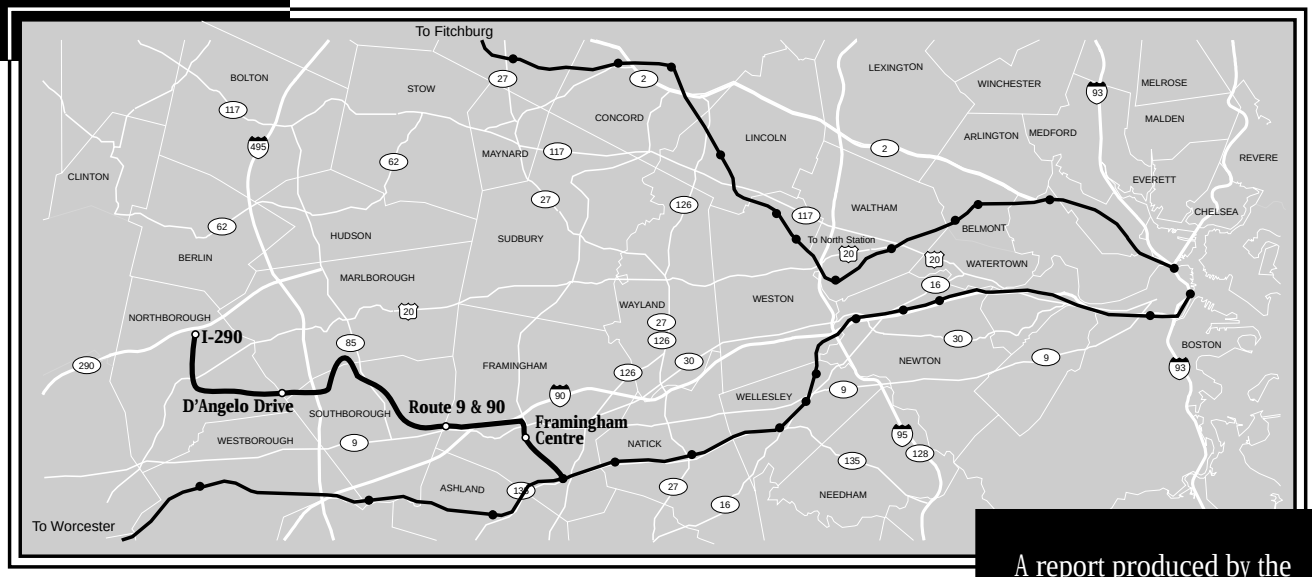
I-290/ Northborough Commuter Rail Extension Feasibility Study



A report produced by the Central Transportation Planning Staff for the Massachusetts Bay Transportation Authority

I-290/Northborough Commuter Rail Extension Feasibility Study

Author
Thomas J. Humphrey

Contributing Analyst
Christopher Parker

Graphics
Kenneth A. Dumas

Cover Design
Jane M. Gillis

The preparation of this document was supported by Massachusetts Bay Transportation Authority Contract X94PS03.

Central Transportation Planning Staff
Directed by the Boston Metropolitan Planning Organization. The MPO is composed of state and regional agencies and authorities, and local governments.

April 2002

TABLE OF CONTENTS

LIST OF FIGURES AND TABLES

FIGURES

TABLES

EXECUTIVE SUMMARY

Rail passenger service between Marlborough and Boston via Framingham was last operated in 1937. This service used a combination of the present MBTA Framingham/Worcester commuter rail line, the present CSX Corporation Fitchburg Secondary Track, and a now-abandoned spur track from Marlboro Junction, on the border of Southborough, to a station south of Main Street near Marlborough City Hall. Portions of the right-of-way of this spur are now occupied by new roads. The closest point to downtown Marlborough on an active railroad line is the former Marlboro Junction Station site. Passenger service on the Fitchburg Secondary Track north of Marlboro Junction to Northborough and beyond ended in 1931.

Marlborough city officials and business leaders have recently expressed strong interest in reinstitution of commuter rail service to the Marlborough area via the Fitchburg Secondary Track and have requested that the MBTA examine the feasibility of such service. This report presents the results of the feasibility study, which was performed for the MBTA by the Central Transportation Planning Staff (CTPS).

Project Description

The study analyzed a commuter rail extension over the Fitchburg Secondary track from Framingham Station through Southborough and Marlborough to the vicinity of Route I-290 in Northborough. A further extension beyond I-290 toward Fitchburg was also examined, but it was found that it would produce little additional benefit compared with an extension only to I-290. Several different levels of service were analyzed, and consideration was given to use of trains of self-propelled diesel multiple-unit (DMU) cars as an alternative to trains of diesel locomotives and coaches similar to those run on present MBTA commuter rail lines.

The map on page ES-3 depicts the route of the Fitchburg Secondary Track. Further study would be needed to finalize station locations for reinstituted service. The demand analysis, and preliminary examination of present land use in the corridor, indicate that in addition to a terminal in Northborough the extension should include one station in Marlborough and two in Framingham. Based on rail distance from South Station in Boston, a Northborough station would be in fare Zone 8 and a Marlborough station would be in Zone 7. One of the Framingham stations would be in Zone 6 and the other would be in Zone 5. The extension could also include a station in Southborough, in Zone 6, but such a station would mostly draw riders away from a new station about to be built in Southborough on the Framingham/Worcester line.

The distance from Framingham Station to the I-290 terminal site would be about 15.7 miles. The route is still an active freight line, but it would require substantial upgrading before passenger service could be implemented. The additional distance from I-290 to Fitchburg is about 21 miles. The northernmost four miles of the line have been out of service for many years, although not officially abandoned.

Ridership Potential

Of the three municipalities assumed for purposes of analysis to have stations on an I-290 extension, only Framingham is now served directly by any commuter rail line. Commuter rail riders from other points in the direct and indirect service area of an I-290 extension currently go to stations on the Framingham / Worcester or Fitchburg Lines. Some of these riders would find those stations or the new ones soon to be added between Framingham and Grafton preferable to I-290 extension stations on the basis of access times, line-haul times, train frequencies, or fares.

The maximum level of service on an I-290 extension assumed for purposes of analysis would provide 17 trains each way per day, including four in each direction during peak periods. This service would attract an estimated 2,160 inbound riders per day at year 2000 travel levels, increasing to 2,730 by 2020. These totals would include respectively about 1,200 and 1,480 new transit users. If reverse-commuting service were limited only to trains that would be run anyway as by-products of peak-direction service, inbound weekday boardings would drop to about 1,970 in the year 2000 or 2,500 by 2020, including 1,010 and 1,250 new transit riders. A start-up service level limited to three inbound A.M. peak and three outbound P.M. peak trips would attract about 1,055 inbound riders per day in 2000 or 1,345 in 2020, including 530 or 655 new transit users.

The estimates above were produced by a multi-step manual process. The predominant source of ridership on all MBTA commuter rail lines is work trips to Boston and Cambridge. These accounted for 85% of the total ridership on the South Side lines in operation at the time of the 1993 survey, and for 78% on the Old Colony lines as of 1998. The first step in the ridership forecast was to estimate the total number of work trips to Boston and Cambridge from each city and town in the extension service area by all means of travel in the years 2000 and 2020. These estimates were based on Census data, population and employment projections, and adjustments for probable changes in proportions of residents working in Boston. The second step was to estimate the share of this travel that the commuter rail system as a whole, including the I-290 extension, could be expected to capture. Finally, an estimate was made of the share of these commuter rail riders who would use the I-290 extension.

After estimating Boston and Cambridge work trips on the extension from each origin, factors were added for non-work trips and trips continuing beyond Boston or Cambridge, based on survey results from the present lines. Also, estimates were made of reverse-commuting and interzone ridership, based on the trip attractions served by the extension, the proximity of stations to these attractions, the assumed service characteristics, and the shares of similar travel captured by existing lines.

Based on projections by the Metropolitan Area Planning Council (MAPC), total employment in the city of Boston will show a net increase of about 23% between 1990 and 2020. Forecasts of growth in Boston employment by city or town of residence have not been made, but overall population of communities in the MAPC Region is projected to increase by about 10% in this time span. Between 1990 and 2020, the I-290 extension

I-290/Northborough COMMUTER RAIL
Feasibility Study
ALIGNMENT OF RAIL ROUTE TO I-290

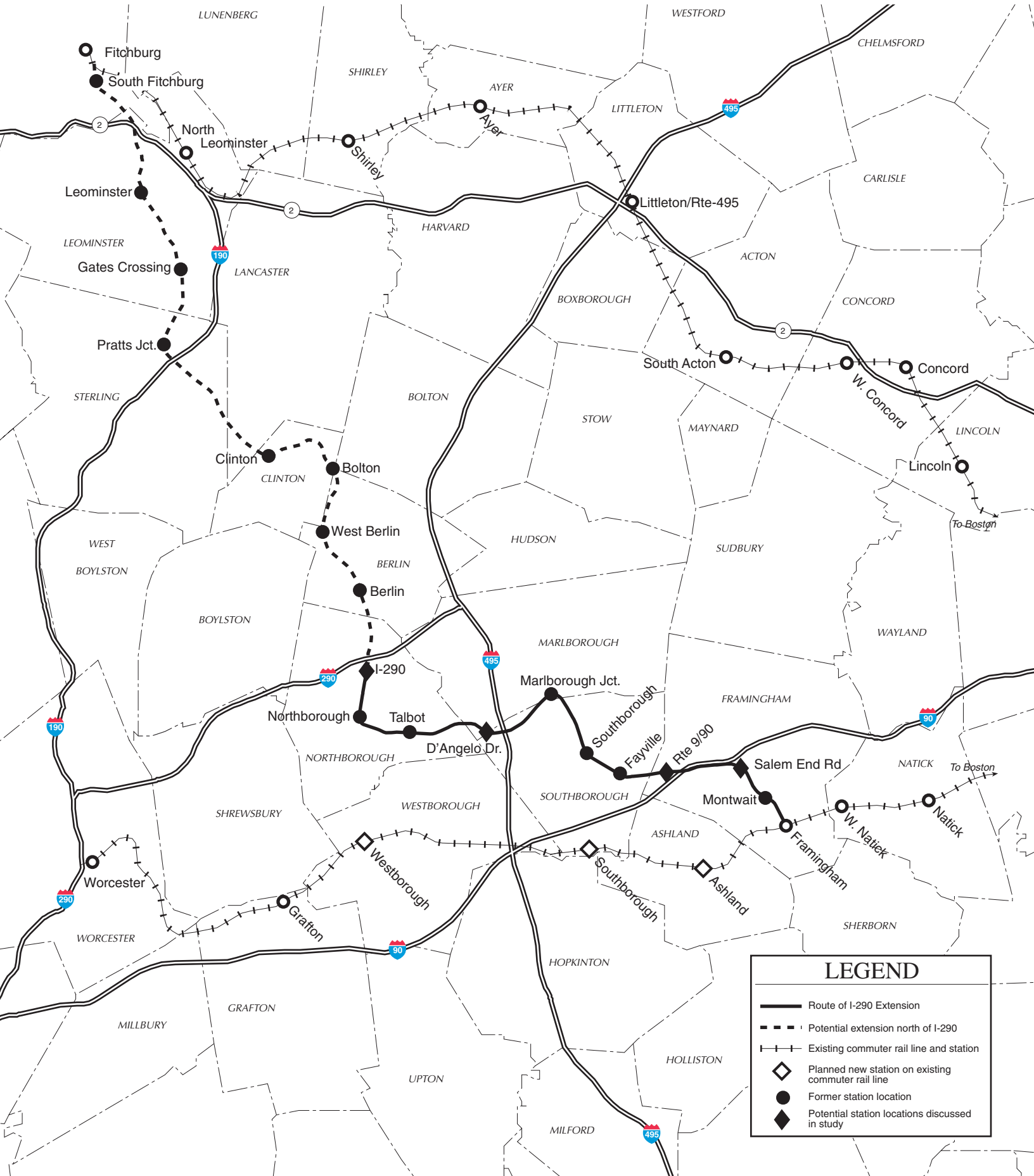


Table ES-1
I-290 Extension Alternatives
Estimated Weekday Inbound Riders by Category
at year 2000 and 2020 travel levels

Item	Limited Weekday Peak Service	Full Service with Limited Reverse Commute	Full Service with Maximum Reverse Commute
New Inbound Transit Riders (Year 2000)	530	1,010	1,200
Former Transit Users Diverted to Extension (2000)	525	960	960
Total Weekday Inbound Riders (Year 2000)	1,055	1,970	2,160
New Inbound Transit Riders (Year 2020)	655	1,250	1,480
Former Transit Users Diverted to Extension (2020)	690	1,250	1,250
Total Weekday Inbound Riders (Year 2020)	1,345	2,500	2,730

service area is expected to show population growth substantially above the MAPC Region average, at 24%. Growth in individual towns in the service area is projected to range from 4% in Framingham to 87% in Bolton. About half of the overall projected growth from 1990 had already occurred by 2000, but space available for further development will slow the future pace. Because of rising housing prices in suburbs closer to Boston, the proportions of extension service area residents employed in Boston or Cambridge are likely to increase at faster rates than overall population. This factor was considered in the demand forecasts. Combined with the total growth in population, the factors used would result in an increase of about 24% in total travel to Boston or Cambridge from the extension service area between 2000 and 2020.

A separate set of ridership forecasts for the extension was produced using the CTPS Regional Model. The total ridership levels in those forecasts were very close to those produced by the manual method described above, although there were some differences in the estimated distribution of riders by origin location and boarding station.

Capital Cost Estimates

Estimated capital costs for several service alternatives for an I-290/Northborough extension are summarized in Table ES-2. It should be noted that these are based on a preliminary examination of the facilities needed rather than on detailed engineering studies. The extension would use a rail line that is still used for freight service, but the

Table ES-2
Summary of Capital Costs
for I-290 / Northborough Extension

Item	Amount
Total Capital Cost for limited service peak-period, peak-direction only	$131,880,000
Capital Cost Per New Transit Rider (2020)	$201,345
Total Capital Cost for full service with limited reverse commuting	$172,375,000
Capital Cost Per New Transit Rider (2020)	$137,900
Total Capital Cost for full service with maximum reverse commuting	$192,520,000
Capital Cost Per New Transit Rider (2020)	$130,080

track is in only fair condition and would need to be entirely rebuilt to make it suitable for passenger service. It would also require a new signal system and entirely new stations and parking facilities. The rolling stock costs included in the figures in Table ES-2 assume use of diesel locomotives and push-pull coaches. Use of Diesel Multiple-Unit (DMU) trains would result in slightly lower costs for some alternatives and slightly higher costs for others. A large part of the capital cost requirements would be for fixed facilities and would vary little with service frequency. Therefore, the average cost per passenger would be lowest for the alternatives with the greatest ridership, even though these would also have the highest absolute cost requirements.

Operating Cost and Revenue Estimates

For this study, the only outer endpoint considered for an extension was one in the vicinity of Route I-290 in Northborough. Therefore differences among alternatives in operating costs were mostly a result of differences in the number of train trips assumed to be operated each day. For each alternative level of service, costs were calculated both for push-pull trains and for DMUs.

Table ES-3 summarizes the incremental revenues and operating costs and revenue-to-cost ratios for the three weekday service alternatives considered for an I-290 extension. Operating costs and revenues for Saturday and Sunday service are shown separately because weekday service could be provided either with or without weekend service. The costs and revenues in the table are for ridership, fare structure, and unit operating costs for the year 2000. Operating costs and revenues were not calculated for future years, because the rate at which either can be expected to increase is unclear. Total ridership for the extension is projected to grow by about 26%, but this would not necessarily result in an equal improvement in the revenue-to-cost ratios.

Table ES-3
Cost and Revenue Comparisons
for I-290 Extension (Year 2000 Levels)

Item	Limited Weekday Peak Service	Full Service with Limited Reverse Commute	Full Service with Max. Reverse Commute	Saturday Service	Sunday Service
Annual Operating Cost (Locomotive-hauled)	$2,630,000	$10,525,000	$14,910,000	$1,305,000	$1,180,000
Annual Operating Cost (DMUs)	$2,395,000	$8,300,000	$10,850,000	$870,000	$645,000
Incremental Fare Revenue	$1,230,000	$2,325,000	$2,630,000	$185,000	$110,000
Incremental Revenue / Operating Cost (Locomotive-hauled)	0.468	0.221	0.176	0.142	0.093
Incremental Revenue / Operating Cost (DMUs)	0.514	0.280	0.244	0.213	0.171
New Transit Riders per day (Year 2000 travel levels)	530	1,010	1,200	350	205

Note: Revenue and cost figures for full-service alternatives include only weekday service

Of the alternatives examined, a basic service with schedules limited to peak-period peak-direction trains on weekdays only would have the highest revenue-to cost ratio, at about 47% with push-pull trains or 51% with DMUs. Such a service would also have the lowest total ridership and the highest capital cost per new transit rider. It would also be the least likely service to be operated over the long term, based on the comparative levels of service offered on present MBTA commuter rail lines.

The alternative with schedules most similar to those of present lines is that of full peak-direction service but minimal reverse-commuting service. That would have a weekday revenue-to-cost ratio of about 22% with push-pull trains or 28% with DMUs. For comparison, the overall revenue-to-cost ratio for weekday service on the present lines using the same revenue and cost formulas applied to the extension is about 48%

Operational Issues

Trains serving an I-290 extension would use the tracks of the Framingham / Worcester commuter rail line between Framingham Station and Boston. This is also the most heavily used rail freight route into Boston. In addition, it carries a limited amount of

intercity rail traffic. Schedules of I-290 trains would have to be coordinated with the schedules of all of these, and all services would need to adhere closely to their schedules to avoid delays to one train spreading to several others. Available time slots would not necessarily match times of greatest potential demand.

Between Framingham Station and I-290, the extension would use the CSX Corporation's Framingham North Yard tracks and Fitchburg Secondary Track. Operation of passenger trains on that line would require an agreement with CSX. At present, most of the Fitchburg Secondary is used by only one freight train a day in each direction, but switching activity along the line could conflict with midday passenger service operations.

To meet Architectural Access Board requirements, the present MBTA standard for new stations calls for full-length high-level platforms. In general, CSX does not permit installation of such platforms on lines it owns unless bypass tracks are provided for wide freight cars. Use of low-level platforms on an I-290 extension would require granting of a variance by the Access Board or through legislative action.

The Framingham North Yard is used continuously for sorting of cars being transferred between long-distance and local freight trains. Provision of a clear track through this area at all times for passenger trains could be difficult.

The Boston terminal for I-290 trains would be South Station. There is currently capacity available there for addition peak-period trains, but planned service increases on existing lines and extensions including the Greenbush and Fall River / New Bedford lines are expected to fully utilize this capacity. Therefore, operation of I-290 trains could prove to be infeasible without further expansion or reconfiguration of South Station.

Present maintenance facilities in Boston for South Side commuter rail lines are operating at close to capacity. The impact of an I-290 extension on maintenance facility requirements in Boston, and the associated costs, would need to be examined as part of the overall strategy for maintaining rolling stock for present service and for new extensions and service improvements. Such an analysis was beyond the scope of the present study.

Environmental Impacts of I-290 Extension

Impacts on Air Quality

Based on the alternate travel modes of the expected users of I-290 extension rail service, a schedule including maximum feasible peak-direction and reverse-commuting train frequencies would reduce automobile vehicle miles of travel (VMT) by 41,480 per day at year 2000 travel levels. With full peak-direction service but limited reverse-commuting schedules, the reduction would be would be 35,140. With service limited to only inbound A.M. peak and outbound P.M. peak trains, VMT reduction would be 19,325 per

day. Taking into account the emissions from diesel locomotives or DMUs used on I-290 trains, the net impacts on air quality would be as shown in Table ES-4.

Other Environmental Impacts

An I-290 extension would not have any other significant adverse impacts on the environment. Development along most of the right-of-way of the extension is relatively light, and few cultural resources would be impacted. A total of about 200 houses are currently within 200 feet of the route. More development is, however, likely to occur near some segments of the line in the future.

In Southborough, the Fayville Village Hall is within 200 feet of the right-of-way. In downtown Northborough there is a church within 200 feet of the track, and at Framingham Centre there is a church within 500 feet. Otherwise, no community or cultural resources are sufficiently close to the right-of-way to be impacted by an extension to I-290.

An I-290 extension would not reduce traffic significantly on any highway. The maximum absolute reduction would occur on the Mass. Turnpike east of Interchange 13 in Framingham, where auto diversions in the peak half hour would equal about 3% of the capacity of the road.

Peak auto arrival rates at stations on an extension would be much lower than those at Framingham Station, now used by the largest number of riders from the extension service area. In the final minutes prior to departure of the most heavily patronized train, auto arrivals at the busiest station would average about 17 per minute, and these would not all arrive from the same direction.

The tracks that would be used for an extension from Framingham to I-290 currently have 12 grade crossings of public roads. The most heavily traveled of these is that of state Route 9 at Framingham Centre. The most recent available traffic counts there show a maximum hourly total of about 2,450 eastbound vehicles in two lanes.

Table ES-4
I-290 Extension with Year 2000 Ridership
Net Change in Average Weekday Emissions

	Limited Weekday Peak Service	Full Service with Limited Reverse Commute	Full Service with Maximum Reverse Commute	DMU Full Service with Maximum Reverse Commute
CO Change	-186.7 kg	-323.8 kg	-372.0 kg	-397.1 kg
NOx Change	+104.4 kg	+394.0 kg	+559.6 kg	+282.8 kg
VOC Change	-13.3 kg	-19.0 kg	-19.6 kg	-28.4 kg
PM Change	+1.6 kg	+5.9 kg	+8.3 kg	+4.6 kg

The traffic delay caused by a train crossing there would be similar in duration to that at a traffic light at a major intersection. At most, four trains per hour in both directions combined would cross during peak times.

Conclusions

A summary of the ridership and cost analysis results for the I-290 / Northborough commuter rail extension alternatives is shown in Table ES-5. The extension could be feasible from an operations standpoint, but would produce limited benefits for the costs involved. The ratio of incremental revenue to incremental operating cost for the level of service most likely to be operated would be less than half of that for the present MBTA commuter rail system as a whole.

Most of the alternatives would have relatively high capital cost per new weekday transit rider. For an extension to I-290 with full peak-direction and reverse-commuting service, the capital cost per new transit rider shown in Table ES-5 would be $130,081 at year 2020 travel levels. For comparison the Newburyport extension, which opened in 1998, had an estimated cost of $93,055 per new rider. (The most recent estimated capital cost per new transit rider for the Worcester extension, which was the most cost-effective commuter rail extension examined in the PMT, is $45,732.)

The I-290 extension results shown are dependent on the most optimistic justifiable assumptions about new transit ridership attracted by the extension. Lower actual ridership would result in much higher average capital costs per new transit rider than shown in the table and would also reduce the ratio of revenue to operating cost.

Table ES-5
Summary of Performance Measures for
Extension from Framingham to I-290 / Northborough

Item	Limited Weekday Peak Service	Full Service with Limited Reverse Commute	Full Service with Maximum Reverse Commute	DMU Full Service with Maximum Reverse Commute
Weekday Inbound riders (2000 travel levels)	1,055	1,970	2,160	2,160
New Inbound Transit Riders (2000 travel levels)	530	1,010	1,200	1,200
Weekday Inbound riders (Year 2020)	1,345	2,500	2,730	2,730
New Transit Riders (year 2020)	655	1,250	1,480	1,480
Annual Operating Cost	$2,630,000	$10,525,000	$14,910,000	$10,850,000
Incremental Fare Revenue (2000 travel levels)	$1,230,000	$2,325,000	$2,630,000	$2,630,000
Incremental Revenue / Operating Cost	0.468	0.221	.176	0.244
Capital Cost	$131,880,000	$172,375,000	$192,520,000	$184,795,000
Capital Cost / New Rider (year 2020)	$201,345	$137,900	$130,080	$124,860
Weekday VOC Reduction (2000 travel levels)	13.3 kg	19.0 kg	19.6 kg	28.4 kg
Capital Cost / Kg of Weekday VOC Reduction	$9,915,789	$9,072,368	$9,822,449	$6,506,866

1. INTRODUCTION

Rail passenger service between Marlborough and Boston was last operated in 1939. This service used a branch line that diverged from the now-abandoned Central Mass. Branch of the Boston & Maine Railroad in Hudson and terminated at Lincoln Street in Marlborough.[1] Until 1937, passenger service to Marlborough was also operated on a second route using a combination of the present MBTA Framingham / Worcester commuter rail line, the present CSX Corporation Fitchburg Secondary Track, and a now-abandoned spur track from Marlboro Junction, on the border of Southborough, to a station south of Main Street near Marlborough City Hall.[2] Portions of the rights-of-way of both railroad lines into downtown Marlborough are now occupied by new roads. The closest point to downtown Marlborough on an active railroad line is the former Marlboro Junction Station site. Passenger service on the Fitchburg Secondary Track north of Marlboro Junction to Northborough and beyond ended in 1931.

At present, most Marlborough residents who use commuter rail drive to stations on the Framingham / Worcester or Fitchburg lines, with about half using Framingham Station. Marlborough city officials and business leaders have recently expressed strong interest in reinstitution of commuter rail service to the Marlborough area via the Fitchburg Secondary Track and have requested that the MBTA examine the feasibility of such service. This report presents the results of the feasibility study, which was performed for the MBTA by the Central Transportation Planning Staff (CTPS).

A commuter rail extension on the Fitchburg Secondary Track has been the subject of at least two other studies in the past decade. A 1990 study examined an extension as far as Route I-495 in Southborough as a potential alternative to a Worcester extension.[3] The latter was found to be the more cost-effective choice, and is being implemented.

A Southborough / Route 495 extension was examined again for the 1994 update to the MBTA Program for Mass Transportation (PMT). That analysis considered this extension as operating in addition to, rather than instead of, the Worcester extension. Because of the proximity of the two lines, it was found that a Southborough extension would attract relatively few new transit riders and would not be cost-effective.

The present study examines a longer extension on the Fitchburg Secondary Track, running at least as far as Route I-290 in Northborough. The potential demand for reverse-commuting service on the extension is also examined in greater detail than in the prior studies.

---

[1]See CTPS *Central Mass. Commuter Rail Feasibility Study Final Report*. December 1996 for a detailed analysis of potential restoration of service on the Central Mass. Branch, including a possible Marlborough link.

[2]Although the correct spelling of the city name is Marlborough, the railroad stations all used the simplified spelling Marlboro.

[3]See Stone & Webster Civil & Transportation Services, Inc. *Commuter Rail Extension Feasibility Study Framingham to Worcester, Milford, & Marlborough. Final Report*. January 1990.

2. SERVICE AREA

Communities to Be Served

Factors Determining Service Area

The majority of inbound passenger trips on existing MBTA commuter rail lines originate in the cities or towns served directly by those lines.[4] Most other trips originate in towns adjoining those with stations. The outermost station on a line often attracts riders from greater distances than do the intermediate stations, but the size of the end-of-line attraction area may be limited by competition with other lines.

Three of the station sites proposed by the Marlborough Transportation Task Force (as detailed in chapter 3) would be near interchanges with limited-access highways, in order to serve as regional park-and-ride facilities. As discussed in appendix F of this report, highway proximity is only one of many attributes that influence the size of the attraction area of a park-and-ride station. Of the three proposed park-and-ride station locations, the one near Mass. Turnpike Interchange 12 in Framingham would have direct highway access from the greatest number of cities and towns. For reasons detailed in appendix F, however, the number of riders it would attract from beyond Framingham and adjoining towns would not be large enough to influence a decision as to whether or not the I-290 extension should be implemented.

The map on page 5 depicts the expected service area of an I-290 / Northborough extension based on the analysis in the following sections of this chapter and in appendix F. Some riders from other origins could also be expected to use the extension, but in such small numbers that it would be misleading to include these origins on the service-area map.

Cities and Towns Served Directly By I-290 Extension

An I-290 extension would run through the towns of Framingham, Southborough, and Northborough. It would also pass through the south edge of Marlborough in two places, once for a distance of about one third of a mile, and once for about two thirds of a mile. Historically, Framingham, Southborough, and Northborough each had two stations between the present Framingham commuter rail station and I-290 and Marlborough had one. There have been many changes in land use in the more than 60 years since passenger service was last operated on this line, however. When these stations were first established most railroad passengers made their access trips by walking; highway competition for travel to Boston did not develop until much later.

---

[4]Results of the 1993 MBTA commuter rail survey show that on-line origins exceeded 67% on all but the Fairmount Line (65%) and the Attleboro / Stoughton Line (55%). The Attleboro / Stoughton Line has several large regional parking facilities near major commuting highways. The 1998 Old Colony survey found that 75% of the riders on the Middleborough / Lakeville Line and 61% of those on the Plymouth / Kingston Line originated in cities or towns with stations. The lower latter figure was mostly a result of proximity of some stations to borders of towns not served directly.

With present-day residential development patterns such as those found in the Fitchburg Secondary Track corridor, the majority of commuter rail passengers must rely on some form of automobile access even when stations are closely spaced. The train running time between any pair of stations increases directly with the number of intermediate stations. Longer travel times make rail service less attractive for through travel compared with driving, and short-distance ridership attracted by the additional stations is typically very small. Accessibility regulations now require much more elaborate, permanent, and costly platform facilities at new stations than were permitted in the past. All of these considerations dictate that a future I-290 extension should have fewer stations than existed when passenger trains were previously run on the line. (It would be possible, though more costly, to provide some stations that would serve only reverse-peak-direction trains.)

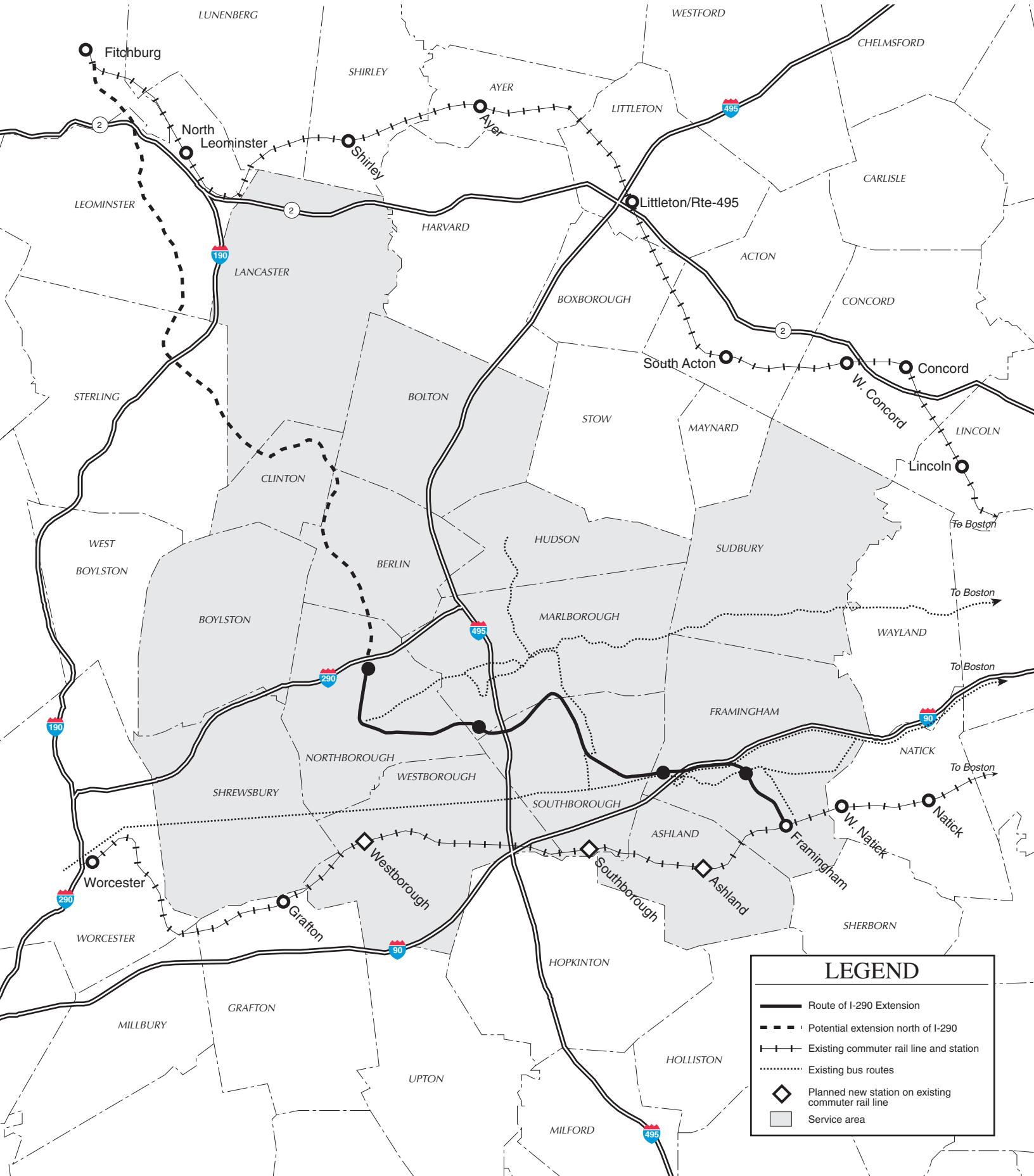
For purposes of analysis, this study assumes that an I-290 extension would have stations in Framingham near Framingham Centre and near the interchange of Routes 9 and I-90; in Marlborough near Route I-495; and in Northborough near Route I-290. There would not be an extension station within Southborough, but the Route 9 & 90 station would be only one half mile from that town's border with Framingham. Therefore, all four cities or towns through which the extension would pass are included in its assumed service area.

Towns Adjoining Direct Service Corridor

To the north, towns adjoining those directly on the extension route are Berlin, Hudson, and Sudbury. Passengers from Berlin could go either to an I-290 station via local roads or to an I-495 station via Routes 85 and 495. Passengers from Hudson could also use either an I-290 station or an I-495 station, but the former would require substantial doubling back. (If there were a station near the former Marlboro Junction site, Hudson residents could access it via Route 85, but would have to drive through downtown Marlborough to do so.) From Sudbury, the nearest extension station would be one near Framingham Centre, which would have to be accessed by local roads. In the 1993 survey the most common boarding station for Sudbury residents using commuter rail was Lincoln on the Fitchburg Line. Use of a Framingham Centre Station would reduce combined access and line-haul times from the southern half of Sudbury. Berlin, Hudson, and Sudbury are all assumed to be in the service area of an I-290 extension.

To the west, towns adjoining those directly on the extension route are Boylston, Shrewsbury, and Westborough. Passengers from either Boylston or Shrewsbury would have good access to an I-290 station via I-290 itself. Westborough residents could use several of the extension stations, but the majority of them would find this less convenient than using the station now under construction in Westborough on the Framingham/Worcester Line. For purposes of analysis Boylston, Shrewsbury, and Westborough are all assumed to be in the service area of an I-290 extension.

I-290/Northborough COMMUTER RAIL
Feasibility Study
SERVICE AREA FOR I-290 EXTENSION



Towns directly to the south of those on the Fitchburg Secondary Track are Hopkinton and Ashland. From most points in Ashland, it would be more convenient to use either the new station being built in that town on the Framingham / Worcester Line or the present Framingham Station rather than any station on an I-290 extension. A Framingham Centre station could, however, provide the fastest travel times to Boston from a few origins near the northern border of Ashland. Although Hopkinton adjoins Southborough, either the new Southborough station under construction on the Framingham / Worcester Line or the new Ashland station would have more convenient access from Hopkinton and would provide faster travel times to Boston than any station on an I-290 extension. For these reasons, Ashland is included in the assumed service area of an extension, but Hopkinton is not.

The only towns directly adjoining those on an I-290 extension to the east are Wayland and Natick, both of which adjoin Framingham. Natick is served directly by two stations on the Framingham / Worcester Line. No station on an I-290 extension would be more convenient for trips from Natick toward Boston, although the Natick stations could be used as boarding points for reverse-commuting trips to the extension corridor. From Wayland, use of any station on an I-290 extension for travel toward Boston would result in excessive doubling back compared with using a station on one of the existing commuter rail lines. For these reasons, Wayland and Natick are assumed to be outside the service area of the extension for Boston-bound travel. (The reverse-commuting market is considered separately.)

Towns Beyond Those Adjoining Direct Service Corridor

Any towns in the service area of an I-290 extension other than those discussed above would have to be beyond those adjoining the communities with stations. The next towns to the north of Berlin and Hudson are Bolton and Stow. Stow is closer to the South Acton or West Concord stations on the Fitchburg Line than it would be to any station on an I-290 extension. Bolton would be slightly closer to a Route 495 station on an I-290 extension than to any existing commuter rail stations currently used by Bolton residents. Therefore, Bolton would be in the service area of an I-290 extension, but Stow would not be.

The next communities to the west of Berlin, Boylston, and Shrewsbury are Clinton, West Boylston, and Worcester. The outer terminal of the Framingham / Worcester Line is in downtown Worcester. For residents of some areas in northeastern Worcester, overall travel times to Boston via an I-290 / Northborough station would be slightly faster than those via Worcester Station, but access to the latter from these areas would still be more convenient. These neighborhoods account for a relatively small portion of total Worcester population. The percentage of total commuter rail travel from Boston to Worcester likely to be attracted to an I-290 extension would be so small that Worcester is categorized as being outside the service area of the extension. Of the few Worcester residents who would go to I-290, most would be diversions from Worcester Station rather than new transit users. An I-290 station would be in a lower fare zone (Zone 8 versus Zone 9), so including Worcester riders in the demand estimates would reduce

net revenue projections slightly from those included in other chapters in this report. (More detailed comparisons of travel times via Worcester Station with those via an I-290 station are contained in appendixes B and F.)

In West Boylston, the largest concentration of population is in an area with better access to Worcester Station than to an I-290 extension. Clinton has relatively poor highway access to any existing commuter rail station, but might be slightly better served by an I-290 extension. For these reasons, Clinton is assumed to be in the service area of an extension, but West Boylston is assumed not to be.

As discussed above, the towns directly adjoining the I-290 extension towns to the south would not be served by the extension. Therefore, towns even further to the south of these would not be served either.

Three additional towns bordering one or more of those included above in the I-290 extension area were also considered for possible inclusion. These were Sterling (west of Clinton), Lancaster (north of Clinton), and Harvard (north of Bolton). From Sterling, highway access to North Leominster Station on the Fitchburg Line is much more convenient than access to any station on an I-290 extension would be. Census and survey data show very low total Boston or Cambridge work travel from Sterling. Therefore it was excluded from the assumed extension service area.

Lancaster also has relatively low total Boston or Cambridge work-trip orientation. Driving time from Lancaster to an I-495 station on the extension would be slightly faster than the present most common choice of driving to South Acton, but train time from I-495 to South Station would be slightly longer than express train time from South Acton to North Station. The extension could attract some Lancaster residents with Boston destinations closer to South Station or Back Bay than to North Station. Lancaster is therefore included in the extension service area.

From Harvard, driving time to an I-495 station would be significantly longer than the present most common choice of driving to South Acton. Survey results show that Harvard residents board Fitchburg Line trains at several other stations in addition to Harvard, and that those making the longest access drives are reducing both their total travel times and their fares. For most Harvard residents, total travel times to Boston would be greater via an I-290 extension than via one of the Fitchburg Line stations, and fares would be as high or higher. There would be slight travel time and fare savings for diversions from Ayer Station, but the survey results imply that for Harvard residents boarding at Ayer, the most important consideration is minimizing access time. For these reasons, Harvard is not included in the assumed service area of an I-495 extension.

Because of highway access provided by the Mass. Turnpike and connecting highways, a Route 9 & 90 station in Framingham would at first appear to have a very large service area. As detailed in appendix F, however, most of the cities and towns that would have convenient access to this station and that also generate significant numbers of trips to Boston also would have more convenient service via other commuter rail stations.

Existing Transportation Services

Present Railroad Facilities in Service Area

An I-290 / Northborough commuter rail extension would use rail lines known as the Framingham Secondary Track and the Framingham North Yard Tracks. Ownership of these lines was transferred to the CSX Corporation on June 1, 1999, as part of the division of Conrail between CSX and the Norfolk Southern Corporation. The Framingham North Yard Tracks extend from a connection with the Framingham / Worcester commuter rail line at Framingham Station to Framingham Centre,[5] just north of state Route 9. The portion of the Fitchburg Secondary Track that is the main focus of this study begins at Framingham Centre and runs northwest through Framingham, Southborough, Marlborough, and Northborough. Beyond I-290 the line continues through Northborough, Berlin, Bolton, Clinton, Lancaster, Sterling, and Leominster to a connection with the Fitchburg commuter rail line about one half mile east of Fitchburg Station. The northernmost four miles of this line between Leominster and Fitchburg have been out of service since the mid 1980s, but have never been officially abandoned.

The Fitchburg Secondary Track has been used exclusively for freight service since 1937, when passenger service between Framingham Station and Marlborough was discontinued. Passenger service north of Marlboro Junction to Fitchburg ended in 1931. In the final years of service, passengers traveling between stations on the Fitchburg Secondary and Boston had to transfer at Framingham Station. In earlier years, some trains or cars were run through to Boston from Fitchburg or Marlborough in addition to service requiring transfers.

Framingham is currently served directly by the Framingham / Worcester commuter rail line, and work on a new station on this line in Southborough is proceeding. Leominster and Fitchburg are both served by the Fitchburg commuter rail line. None of the other towns on the Fitchburg Secondary Track have direct rail passenger service at present, but all of them except Northborough once had some such service in addition to that provided via the Fitchburg Secondary Track

Clinton, Lancaster, and Sterling are all located on a Guilford Rail System freight line that connects with the Framingham / Worcester Line at Worcester and with the Fitchburg Line at Ayer. Historically, this line never had Boston-oriented passenger service via either Worcester or Ayer, but it did have through service from Clinton, Lancaster, and Sterling to Boston via the now-abandoned Central Mass. line for many years. Berlin, Clinton, and Bolton all once had stations directly on the Central Mass., and Marlborough was once served by a branch diverging from the Central Mass. in Hudson.

[5]The spellings "Center" and "Centre" can both be found on documents referring to this location. For consistency throughout this report, the railroad spelling "Centre" will be used.

Present Highway Facilities in Service Area

An I-290 / Northborough extension would be used predominantly for travel from communities in its corridor to Boston and Cambridge. In most of the area that would be served by the extension, present limited-access highways are oriented more for circumferential travel or for travel to and from Worcester than for travel to Boston or Cambridge. Framingham, which has two interchanges on the Mass. Turnpike, is the only exception. The Turnpike also passes through Southborough, but the nearest interchange to that town is in Framingham. Similarly, I-495 runs through Southborough, but the nearest interchange is across the town line in Westborough. Marlborough has three interchanges on Route I-495, including one recently added at Industrial Park Drive, but the orientation of I-495 in that city is north-south. It does, however, provide connections with the Mass. Turnpike to the south and with Route 2 to the north for Boston travel. Marlborough is also at the east end of Route I-290, which runs southwest to Worcester.

The only limited-access highway serving Northborough directly is I-290, with two interchanges in that town. The fastest highway travel from Northborough to Boston requires a zigzag route via I-290, I-495, and the Mass. Turnpike. Northborough and Marlborough both also have east-west highway service via U.S. Route 20, and Southborough is on state Route 9, but these are both unlimited-access roads with many traffic lights and curb cuts.

The situation along the segment of the Fitchburg Secondary Track between Northborough and Fitchburg is much the same as on the south end. Berlin and Bolton both have interchanges on I-495, but no east-west limited-access highways. Clinton has no limited-access highways at all. Sterling and Lancaster both have interchanges on Route I-190, which has a north-south orientation between Worcester and Leominster. Sterling has no east-west limited-access highways, but Lancaster has several interchanges on Route 2, as do Leominster and Fitchburg.

Present Public Transportation Serving the Study Area

Commuter Rail

As noted above, of the cities and towns that would be in the direct service area of an I-290 Northborough extension, Framingham is served directly by the Framingham / Worcester commuter rail line and Southborough will have a station on the same line. Ashland and Westborough, which would be served indirectly by the extension, will also have stations on the Framingham / Worcester Line. None of the other communities in the extension service area are now served directly by any commuter rail lines. The 1993 survey results show that most residents of these cities and towns who used commuter rail then rode the Framingham / Worcester or Fitchburg lines.

Table 2-1

Weekday Inbound Ridership at Present Commuter Rail Stations for Trips Originating in Northborough / I-290 Extension Service Area in 1993

	Origin														
Boarding Station	Framingham	Southborough	Marlborough	Northborough	Ashland	Sudbury	Shrewsbury	Westborough	Hudson	Clinton	Bolton	Lancaster	Boylston	Berlin	**Total**
Framingham/ Worcester Line															
Worcester				2			41	1		2		1	1		48
Framingham	508	23	35	7	118	2	6	31	3				2		735
West Natick	125	3	5		40	5	2	5							185
Natick	15				10			4							29
Wellesley Square	17		3		4		2	3							29
Wellesley Hills					3	2									5
Wellesley Farms	8					3	2								13
Auburndale	12					3									15
Subtotal	685	26	43	9	175	15	53	44	3	2	0	1	3	0	1,059
Fitchburg Line															
North Leominster												1			1
Shirley												3			3
Littleton / Route 495							2			1	2				5
South Acton			2			4			16	14	16	11			63
West Concord						3			2	5					10
Concord								1							1
Lincoln	3		9			67			4						83
Kendal Green	4					7									11
Brandeis / Roberts	6										3				9
Waltham			11												11
Subtotal	13	0	22	0	0	81	2	1	22	20	21	15	0	0	197
Other Lines															
Subtotal					1			3							4
Total	698	26	65	9	176	96	55	48	25	22	21	16	3	0	1,260

Table 2-1 summarizes the expanded survey results for weekday inbound trips originating in the expected service area of an I-290 extension.[6] A total of 1,260 weekday inbound commuter rail trips originated in the cities and towns that would be served directly or indirectly by a Northborough/I-290 extension. Of these, 698 originated in Framingham, and 562 originated in twelve of the other communities. (There were no survey responses from Berlin, and 1990 Census figures also show negligible rail use from that town.)

Framingham Station was the boarding point for the largest single share of these trips, with 735 boardings (58%). Among trips originating in communities other than Framingham in the I-290 extension service area, 40% of boardings (227) took place at Framingham Station.

West Natick was second overall with 185 boardings from the I-290 extension service area (15%), but it served a smaller share of these trips originating outside Framingham (60 trips, 11%). Stations other than Framingham and West Natick served under 10% of the trips from Framingham origins, but served 49% of the trips from the other extension-area origins. In the latter category, Lincoln was the most heavily used station, with 80 ons (14%), all from Sudbury, Marlborough, and Hudson. South Acton was second with 63 ons (11%), mostly from Hudson, Bolton, Clinton, and Lancaster. Worcester was third with 48 ons (9%) mostly from Shrewsbury. The other boardings from this sub-group were scattered among many stations, with no individual station serving as much as 3%. (A January 2001 license plate survey at Grafton Station found 140 cars from origins in the I-290 extension service area at midday, but the majority of these may have been diverted from older services included in the table totals.)

Other MBTA Service

Table 2-2 summarizes total ridership from the I-290 extension service area on all present mass transit services (except Grafton Station), based on the most recent count or survey results available for each. No MBTA rapid transit, light rail, or bus service is operated directly in any communities in the service area of an I-290/Northborough extension. The nearest boarding points for such service are Riverside Station (Green Line or express bus), other Newton stations on the Green Line, and Alewife on the Red Line.

Survey results from 1994 indicate that on a typical weekday about 250 trips starting in cities and towns in the I-290/Northborough extension service area were made via the Green Line, with 47% of them originating in Framingham. The Riverside and Woodland stations on the D Line were the most common boarding points, serving about 75% of the Green Line trips from the study area.[7] Another 115 trips from the study area were made via the Red Line, with Sudbury accounting for about 33% of the

[6]The Worcester extension opened in September 1994. Boardings shown for Worcester Station are based on a February 1995 survey. Boardings at other stations in Table 2-1 have been adjusted to account for diversions to Worcester.

[7]These totals exclude passengers using the Green Line only for downtown Boston distribution from another form of public transportation such as commuter rail or express bus.

Table 2-2
Weekday Inbound Ridership on Present Mass Transit Services for Trips Originating in I-290 / Northborough Extension Service Area
In 1993 - 1995 MBTA Surveys and 2000 Private-Carrier Surveys

Existing Mass Transit Service	Riders from I-290 Ext. Service Area
Framingham Commuter Rail	1,060
Fitchburg Commuter Rail	195
Other Commuter Rail Lines	5
Green Line	250
Red Line	115
MBTA Express Bus	75
Private-Carrier Bus	125
Total	1,825

origins, Marlborough for about 14%, and the rest being scattered. Alewife alone served most of the Red Line boardings from the study area.

About 60 trips from the extension service area were made by boarding MBTA express bus Route 500 at Riverside Station. These included about 20 each from Framingham and Sudbury, but fewer than 10 from any other individual city or town. The only other use of MBTA express buses shown in the survey was about 10 trips from Marlborough on Route 505 in Waltham and about five from Lancaster on Route 504 from Newton Corner. (The bus totals other than those from Route 500 were expanded from very small samples, and are therefore imprecise.)

Private-Carrier Express Bus Service

Three private companies operate express bus routes to downtown Boston from towns that would be served directly by an I-290 extension, but none of these routes have frequent service. One of these routes runs from Northborough to Boston via routes 20 and 128 and the Mass. Turnpike. Another runs from Hudson to Boston via Route 85 and local roads to Mass. Turnpike Interchange 12 in Framingham and the Turnpike from there to Boston. The third Route runs from Worcester to Shoppers World in Framingham via Route 9 and from there to Boston via the Mass. Turnpike.

Of the 14 cities and towns shown in Table 2-1 that would be served directly or indirectly by an I-290 extension, eight have at least one stop on one of the three express bus routes and six do not. The latter are Ashland, Berlin, Boylston, Bolton, Clinton, and Lancaster. Of these, only Ashland currently has feeder bus service to a commuter rail line.

No other private-carrier express bus routes run close enough to the I-290 extension corridor to attract riders from the anticipated service area of the extension. All of the private-carrier express bus routes serving the extension corridor are discussed in greater detail in appendixes A and I. Table 2-2 summarizes present weekday ridership on all mass transit alternatives for trips originating in the extension service area.

Cavalier Coach

The Northborough-Boston route, known as the Post Road Line, is currently operated by Cavalier Coach Corp. It also serves intermediate stops on or near Route 20 in Marlborough, Sudbury, Wayland, and Weston. Of the communities on the route only Marlborough and Northborough would be in the I-290 extension's direct service area, but some Sudbury residents would use a Framingham Centre station. There is one inbound A.M. peak trip and one outbound P.M. peak trip on weekdays only. Since the Fall of 1998 there has also been one outbound early A.M. trip and one inbound early evening trip, but these are run mostly to move the buses for the peak-direction trips between the garage and the outer endpoint of the route. Otherwise, there is no off-peak service. Funding for this route is provided by the MBTA Interdistrict Transportation Service Program (IDTS). The peak-direction trips typically serve 15 to 20 riders each way per day over the entire route. A September 2000 CTPS count of one outbound trip found 16 riders, all boarding in Boston. Of these, nine went to stops in Marlborough, two each to stops in Wayland, Sudbury, and Northborough, and one to Weston.

In September 1998 Cavalier Coach began operating a reverse-commuting route from Boston to industrial and office parks near Route I-495 in Marlborough. Service consisted of one outbound A.M. peak trip and one inbound P.M. peak trip. After completing the morning run, the bus picked up passengers at four hotels near Routes 20 and I-495 and returned non-stop to Boston. Similarly, in the evening the bus ran from Boston to the Marlborough hotels before picking up passengers at the I-495 business area. As of April 2000, the outbound A.M. peak trip had only one rider. A September 2000 count found three riders on the outbound P.M. peak hotel trip. This may have included some work-to-home trips by Marlborough residents. The route was discontinued in April 2001.

Gulbankian Bus Lines

The Hudson-Boston route is operated by Gulbankian Bus Lines. In addition to Hudson, it serves intermediate stops in Marlborough, Southborough, and Framingham. All of these communities would be in the I-290 extension service area, although Hudson would not be served directly. This route is also subsidized through the IDTS program. In Spring 2001 there were four trips per day in each direction, including two inbound in the A.M. peak and two outbound in the P.M. peak. An April 2000 count found 61 riders on the two inbound A.M. peak trips combined. Expanded survey results showed that 37 riders boarded in Southborough, 17 in Marlborough. and 7 in Hudson. There were no boardings in Framingham. Half of the riders (31) boarded at the Gulbankian garage in Southborough, with the majority of these having driven there from Southborough or nearby towns. Overall, 57 of the 61 riders had trip origins in one of the cities or towns that would be served directly or indirectly by an I-290 extension.

Peter Pan Bus Lines

The Worcester / Shoppers World-Boston bus route is operated by Peter Pan Bus Lines. In addition to Worcester and Framingham, it makes stops in Shrewsbury, Westborough, and Southborough. In Spring 2001, this route had three inbound A.M. peak trips and three outbound P.M. peak trips. Two trips each way covered the entire route and one was a short turn between the Edgewater apartment complex on Route 9 in Framingham and Boston. Equipment for the latter was provided by one early morning outbound trip and one early evening inbound trip. There was also one short-turn round trip between Boston and Shoppers World during each peak period. During off-peak hours some Peter Pan and Greyhound buses running between Boston and Springfield, Hartford, or New York made stops at Shoppers World, but did not serve any other stops in Framingham.

The Worcester / Shoppers World-Boston bus route has been running in this configuration only since August 1999. Prior to that, Peter Pan had been running service from Edgewater to Boston in peak hours and a separate route all the way from Worcester to Boston on Route 9 in off-peak hours. CTPS counts in March 2000 showed a total of 66 riders on the four inbound A.M. peak trips. The great majority of these (57) boarded at the park-and-ride lot at Shopper's World. Another three boarded at the Edgewater apartments, two at Framingham Centre, and four at points west of Framingham. Framingham itself accounted for the largest share of actual trip origins (62%), but riders from several area towns drove to Shopper's World to board. Overall, there were 53 riders with origins in cities or towns that would be served directly or indirectly by an I-290 extension.

Feeder Bus Service

In addition to the through bus routes to Boston, Framingham is served by the Local Inter Framingham Transportation (LIFT) system which operates a network of bus routes within the town and also in some neighboring towns. The LIFT system receives funding through the MBTA Suburban Transportation Program for routes within the town, and through the IDTS program for routes connecting with other towns. All LIFT routes include a stop at the Framingham commuter rail station, but most of the service is operated during midday hours. The 1993 survey showed a total of 10 riders transferring to commuter rail from all LIFT buses combined all day. They are included in the reported commuter rail totals.

LIFT Route 5, which originates in Hopkinton, connects points along Route 135 in Ashland with the Framingham commuter rail station. In Spring 2001 there were five-minute connections with two inbound A.M. peak trains, but the two outbound P.M. peak connections required waits of 15 and 25 minutes. The bus took an indirect route between Ashland and Framingham, resulting in scheduled running times two to three times as long as driving times to Framingham Station. The 1993 survey found only one rider from Ashland accessing commuter rail on this LIFT route.

From September 1998 to August 1999 Gulbankian Bus Lines operated a local route from Hudson via Marlborough and Southborough to the Framingham commuter rail station. This route included one round trip in the A.M. peak and one in the early evening. The inbound A.M. trip and the outbound P.M. trip were scheduled to make close connections with commuter trains. The route was discontinued because of low ridership.

In the Spring of 2000 the LIFT system implemented a new route from the Solomon Pond Mall on the north edge of Marlborough to downtown Framingham via Southborough. The routing between downtown Marlborough and Framingham is the same as that of the former Gulbankian route except for some slight changes in Southborough. As of Spring 2001, this route had hourly service on weekdays, providing 16 round trips on the full route, plus one morning inbound trip from downtown Marlborough to Framingham. It would have been possible to use this route as a connection to commuter rail service at Framingham, either for commuting in the direction of Boston or for reverse commuting toward Marlborough. Train and bus schedules were not closely coordinated, however, so transferring passengers would have had to wait at Framingham Station for five to 15 minutes during peak hours.

Worcester Regional Transit Authority (WRTA) Route 17 runs from Clinton through Boylston to downtown Worcester. At present, this route does not serve the railroad station in Worcester directly. By walking several blocks, it would theoretically be possible to make a connection from the bus to one inbound A.M. peak train, but the last outbound bus of the day departs before the arrival of the first outbound P.M. peak train. Scheduled bus running times to downtown Worcester are 50 minutes from Clinton and 35 minutes from Boylston. No riders from either Boylston or Clinton reported taking the bus to the station in the 1995 survey. Those who drove from both towns reported access times of 20 minutes.

WRTA Route 15 provides hourly service from Shrewsbury to Worcester, and does include a stop at the railroad station in Worcester. Passengers using this route as a feeder to commuter rail would have to start out in the opposite direction from Boston. Bus and train schedules are not well coordinated. The average travel time on the bus from Shrewsbury to the Worcester Station would be over 20 minutes, compared with an average of 11 minutes reported in the 1995 survey by passengers who drove from Shrewsbury to Worcester. No passengers reported riding the bus from Shrewsbury to Worcester in the 1995 survey.

During 1999 and 2000 WRTA ran a Route 44 from downtown Worcester to the Solomon Pond Mall in Marlborough, with one intermediate stop at Lincoln Plaza in Worcester. The schedule included trips at times suitable for Worcester residents commuting to and from work at the malls. The scheduled running time from downtown Worcester to the Solomon Pond Mall was 25 minutes.

To use an I-290 extension to travel to the Solomon Pond Mall, a passenger from Worcester would have to take an inbound train to Framingham, transfer to an outbound I-290 train to Northborough, and then use some kind of connecting service

for the distance of over two miles from the I-290 station site to the mall. The train time from Worcester to Framingham alone would be about 10 minutes longer than the time for a bus from Worcester all the way to the mall. Train time from Framingham to the I-290 Northborough station would add at least another 25 minutes excluding waiting time at Framingham. Therefore, the I-290 extension would not offer a viable alternative for commuting from Worcester to the Solomon Pond Mall.

As of Spring 2001, two inbound A.M. peak trains from Worcester made 15-minute connections at Framingham with LIFT Route 7 buses going toward Solomon Pond Mall, and two outbound P.M. peak trains to Worcester provided 10 to 15 minute connections with buses from the mall. Total travel time from Worcester Station to the mall would have ranged from one hour and 43 minutes to one hour and 48 minutes, compared with only 25 minutes for the direct bus route formerly operated from downtown Worcester to the Mall. Since even the latter failed to attract sufficient ridership, it would not be expected that any riders would use the combination of commuter rail and LIFT buses to make this trip.

3. DESCRIPTION OF SERVICE

Alignment

A commuter rail extension to Route I-290 in Northborough from Framingham Station would use portions of rail lines known as the Framingham North Yard Tracks and the Fitchburg Secondary Track. These line segments, which pass through Southborough and Marlborough as well as Framingham and Northborough, are described in greater detail on page 8 in chapter 2. Ownership of these lines was transferred to the CSX Corporation on June 1, 1999, as part of the division of Conrail between CSX and the Norfolk Southern Corporation. Operation of passenger service on these lines would require some form of agreement between the MBTA and CSX. A further discussion of the impacts of an I-290 extension on rail freight service appears in chapter 7.

Stations

Identification of specific station sites on a Northborough / I-290 commuter rail extension is beyond the scope of this study. For purposes of analyzing ridership, travel times, and traffic impacts of the extension, however, it was necessary to make some assumptions about approximate station locations. Actual station locations would be unlikely to differ enough from these to affect the conclusions. As discussed further in appendix F, good highway access and adequate parking facilities would be critical to the success of an I-290 extension, but most of the station sites used in the past lack one or both of these elements. The assumed station sites are mostly at new locations, as shown on the map on page 19.

The 1990 feasibility study, cited in chapter 1, assumed that an extension as far as Route I-495 would have four stations, all with large parking lots or garages. The first station north of the Framingham / Worcester Line was assumed to be at Salem End Road, near Framingham Centre. The second was assumed to be at California Avenue, in the edge of the Framingham Technology Park. This site is near the interchange of Route 9 and the Mass. Turnpike. The third station was assumed to be near Main Street (Route 30) in the center of Southborough. The fourth, and final station was assumed to be just west of Route I-495 in Southborough, near the border of Marlborough. The analysis for the 1994 PMT update assumed the same four stations sites as the 1990 study.

The extension to I-290 in Northborough proposed in June 1998 by the Marlborough Transportation Task force appointed by the Mayor of Marlborough assumed somewhat different station locations. The Task Force initially proposed making the California Avenue / Route 9 & 90 site the only extension station in Framingham. Because of interest from Framingham State College, which abuts the Salem End Road site, the Task Force subsequently indicated that a station might be included there as well.

No station within Southborough was included in the Task Force proposal, but the California Avenue station would be about one half mile from the Southborough / Framingham town line. The I-495 station proposed by the Task Force would be about

0.7 miles west of I-495, at D'Angelo Drive in Marlborough. Beyond that point there would be one other station, near the crossing of the rail line under I-290 in Northborough, west of the Solomon Pond Road interchange. The Task Force proposal envisioned that the extension would eventually be continued further along the rail line toward Fitchburg.

With the exception of a possible Salem End Road station in Framingham, the stations proposed by the Task Force would be located in predominantly industrial areas, near limited-access highways, and would not correspond with sites of former passenger stations on the line. The former sites, which were oriented toward walk-in traffic from residential area, are discussed in appendix F.

Layover Facility

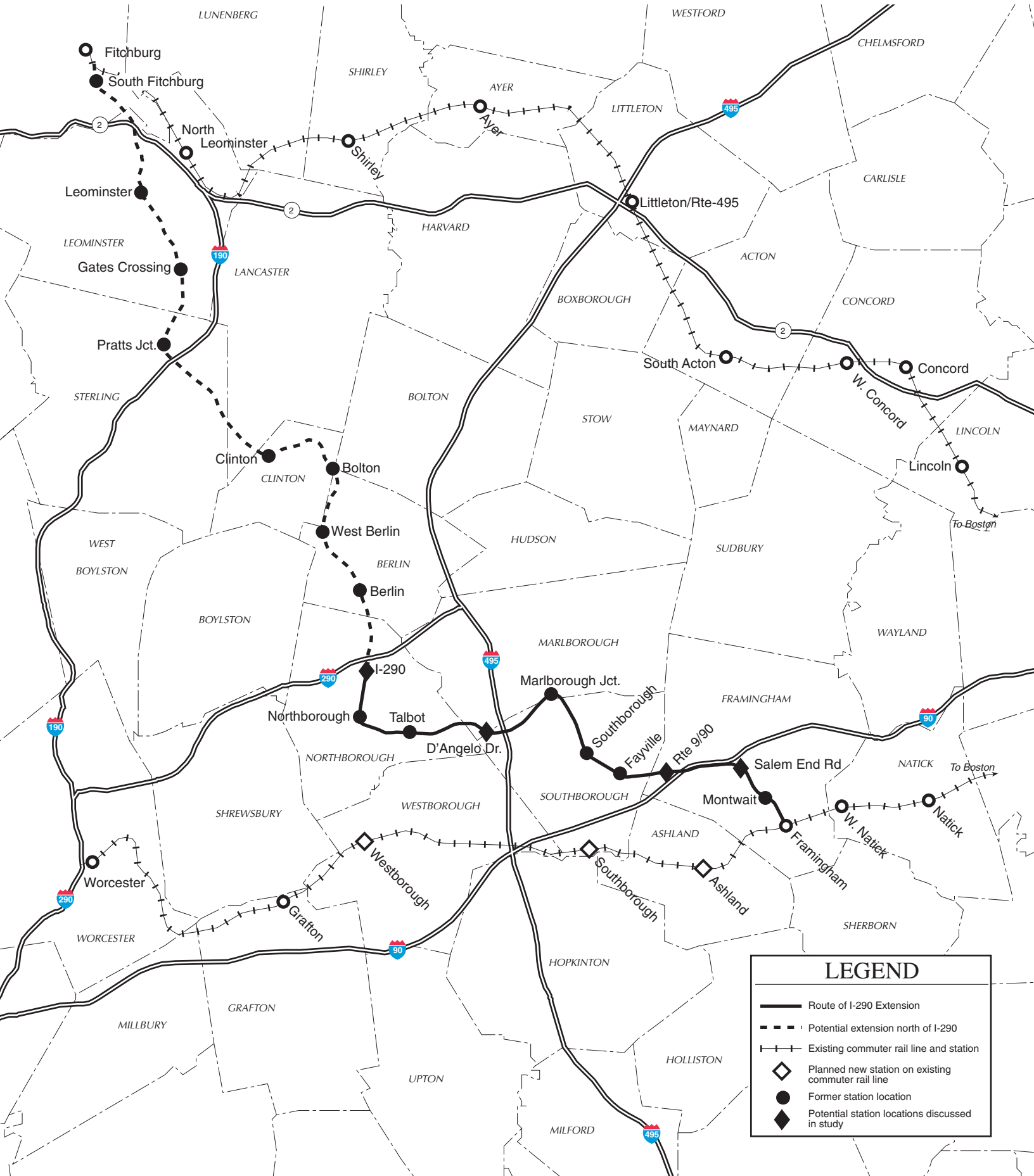
The rolling stock used on MBTA commuter rail lines does not necessarily require any special facilities at the end of a line. On single-track routes such as the Fitchburg Secondary Track, trains can reverse direction at any desired location, with the engine pulling the train on the outbound trip and pushing it on the inbound trip or vice-versa. To minimize non-revenue train mileage, however, it is desirable to provide a yard for overnight storage of trains at or near the outer end of a route.

As of May 2001, A.M. peak inbound service on the Framingham / Worcester Line included three trains from Worcester and three from Framingham, with an additional two trips from Worcester and one from Framingham arriving just after the peak. The Worcester service used four trainsets based overnight at a layover facility in Worcester, and one based in Boston that started the day with a round trip on another line and an outbound trip to Worcester. The Framingham short turns used four trainsets. Two of these were based at the Southampton Street yard in Boston. They were coupled together and run in one lightly patronized early-morning train to Framingham, where they were split for inbound service. The other two sets made outbound trips to Framingham after arriving in Boston from other lines.

If the Framingham local trains originated at I-290 in Northborough instead of Framingham, it would be possible to use the same two trainsets used on the first two departures in the May 2001 schedule by having an earlier outbound departure time from the Southampton Street yard. The two trainsets covering the next two trips would not be able to reach I-290 early enough to return in A.M. peak service, since their departure times from Boston are constrained by prior arrival times.

All trains from all lines that were not already assigned to turn from inbound to outbound trips in the May 2001 schedule would have arrived in Boston too late to be cycled out to any point on an I-290 / Northborough extension for A.M. peak service. Therefore, an I-290 extension with three A.M. peak trips would require at least one additional train set, and service with four A.M. peak trips would require two additional sets.

I-290/Northborough COMMUTER RAIL
Feasibility Study
ALIGNMENT OF RAIL ROUTE TO I-290



As discussed later in this chapter, operation of I-290 extension trains in local-stop service between Framingham and Boston would result in relatively slow and unattractive service for extension users. If I-290 service were run in addition to present Framingham / Worcester service instead of as an extension of Framingham local service, running time considerations would require one new train set for every peak trip. An analysis of running times and available time slots for I-290 trains indicates that four trainsets could provide four peak-direction and three reverse-commuting trips between I-290 and Boston during each peak period. With this amount of equipment, however, cycle times would necessitate leaving long gaps in reverse-commuting schedules during times when demand would be likely to be heaviest. To eliminate this problem, a fourth reverse-commuting trip using a fifth train set would be needed.

Because of limited overnight layover capacity in Boston, an increase in the number of trainsets used on the Framingham / Worcester Line would necessitate providing a new layover facility at some outlying point. The I-495 task force has suggested that trains for an I-290 extension be based at the East Fitchburg facility on the Fitchburg Line. The rail distance from I-290 to East Fitchburg via the Fitchburg Secondary Track is about 24 miles. This would be slightly longer than the length of present equipment-shifting trips between Boston and Framingham, (22 miles), but less than some others such as Boston to Forge Park (30 miles). It would, however, differ from the others in that nearly 22 miles would be over a line that would not otherwise be maintained for passenger train operation. Although there appears to be adequate space available to expand the East Fitchburg layover facility to accommodate trainsets for an I-290 extension, even the present level of operation at this facility has been the subject of complaints from residential abutters because of noise and fumes. Therefore, an entirely new facility would most likely be needed for an I-290 extension.

Running Times

Factors Affecting Running Times From I-290 to Framingham Centre

Train running times between I-290 and Framingham Station would depend on the number and locations of stations served, maximum speed limits, speed restrictions for curves and crossings, the acceleration and deceleration characteristics of the rolling stock used, and the locations of passing tracks. Trains run as extensions of Framingham local trains would have the same running times as those trains between Framingham and Boston. I-290 express trains would have running times similar to those of present Worcester express trains on the segment between Framingham and Boston.

At present, the entire portion of the Fitchburg Secondary Track between Framingham Centre and Route I-290 in Northborough is rated as Federal Railroad Administration (FRA) Class 2. This would allow a maximum speed limit of 30 m.p.h. for passenger trains, which would result in unattractive travel times. Therefore, the line would have to be upgraded to a higher track class prior to introduction of passenger service.

Historically, this line never had very high speed limits. The overall top speed ever permitted for passenger trains was 45 m.p.h., with restrictions of 40 m.p.h. on a curve at Fayville and 30 m.p.h. on a curve at Marlboro Junction. A more detailed engineering study would be needed to determine the maximum feasible speed limits on the Fitchburg Secondary with upgraded track. For reasons detailed below, it is assumed for purposes of analysis that the overall maximum speed limit on an I-290 extension would be 60 m.p.h. Reduced speeds would still be required at several locations.

At present, 60 m.p.h. is the maximum speed limit on most MBTA commuter rail lines. (The Providence Line, also used by high-speed intercity trains, and the Old Colony Lines, which have long station spacing and few sharp curves, are exceptions.) With the probable station spacing on an I-290 extension there would be few segments where trains would be able to accelerate to more than 60 m.p.h. before beginning to brake for the next station. Furthermore, the numerous curves in the line would necessitate some substantial re-alignment of the track for higher speeds. The difference between estimated running times from I-290 to Framingham Centre with a maximum speed limit of 60 m.p.h. and with limits constrained only by station spacing and train performance capability would be less than one minute. Differences from points closer to Framingham Centre would be smaller.

Factors Affecting Running Times From Framingham Centre to Framingham Station

Between Framingham Centre and Framingham Station, all tracks are currently classified as part of the Framingham North Yard. This limits the maximum operating speed for all trains to 10 m.p.h. The possibility of re-classifying some of this segment from yard track to main line would depend on the impact on CSX freight operations in the yard.[8] Based on track configuration and on present practice where main line tracks run past yards, it is assumed for purposes of analysis that speed limits could be raised to about 30 m.p.h. between Framingham Station and the end of the most active yard tracks south of Mount Wayte Avenue, and to about 45 m.p.h. between there and Framingham Centre. Raising speeds to these limits would result in much greater time savings than would increasing speeds north of Framingham Centre to over 60 m.p.h. Specifically, running times between Framingham Centre and Framingham Station would be 8 to 9 minutes less with the changes to 30 and 45 m.p.h. than with the present 10 m.p.h. restriction.

Estimated Running Times from I-290 to Framingham Station

With top speeds of 60 m.p.h. north of Framingham Centre and 30-45 m.p.h. south of there, the total running time from I-290 / Northborough to Framingham Station for a locomotive-hauled train making three intermediate stops would be about 25 minutes. Omitting the Salem End Road station, as originally proposed by the Marlborough Task

[8]Trains operating within yard limits can reverse direction or change tracks as needed to perform switching. Trains operating on main line track can make such moves only under authority of a dispatcher.

Force, would shorten running time by about 1.7 minutes but would also forego the Framingham College market. (The running time savings would result from substituting time at maximum track speed for deceleration, station dwell, and acceleration times.) Conversely, adding more stations would increase running times by an average of about two minutes for each additional stop.

Impact of Use of Diesel Multiple Unit Trains on Running Times

Diesel Multiple Unit (DMU) trains would allow somewhat faster acceleration and deceleration than locomotive-hauled trains, but the running time improvement on an I-290 extension would be relatively small. With typical DMU performance characteristics, the overall time reduction to Framingham Station from I-290 with three intermediate stations would be under two minutes compared with a locomotive-hauled train. Reductions from other stations would range from 0.2 to 1.4 minutes. These savings would be too small to affect ridership levels on the extension, and would have to be weighed against the disadvantages of maintaining a small fleet of rolling stock incompatible with that used on the rest of the system.

Factors Affecting Running Times from Framingham to Boston

The running times between Framingham Station and Boston for I-290 trains would be controlled in part by the speed limits on that segment and the number of intermediate stops made. In addition, the need to coordinate schedules of I-290 trains with those of other passenger trains and freight trains on this segment would affect possible running times. The rail line between Framingham and South Station is mostly double-tracked, with signals allowing trains to run in either direction on either track. There is, however, a 1.7-mile segment of single track past the Beacon Park freight yards in Allston. The need for all trains in both directions to use this single track places some constraints on intervals between scheduled arrival and departure times at South Station.

At present, all stations in Wellesley, Natick, and Framingham have platforms on both tracks, but the three stations in Newton have platforms only on Track 2 (which would be the inbound track in a strict right-hand running operation). Therefore, all trains in either direction that serve the Newton stations are normally run on Track 2.[9] At Newtonville, there is room for a platform for Track 1 on the site of a very deteriorated abandoned platform, but at West Newton and Auburndale major station reconstruction would be needed for installation of Track 1 platforms. At all three stations, the tracks are below street level and can currently be accessed only via long stairways. Any significant alterations to any of these stations would also require that they be made wheelchair accessible.

At Wellesley Hills and West Natick passengers going to or from the Track 1 platform must walk across both tracks from the Track 2 platform. At Wellesley Farms, most

[9]When trains stop on Track 1 at the Newton stations, passengers must walk across Track 2 on narrow boardwalks, and trains must be stopped with doors precisely aligned with the boardwalks.

passengers use the parking lot adjoining Track 2 and also walk across both tracks when going to or from the Track 1 platform. (It is also possible to cross by a road bridge, but the walking path that way is longer.) These at-grade passenger crossings place constraints on the locations and times at which trains on one track can be scheduled to pass trains on the other to ensure passenger safety. A further discussion of these constraints is contained in appendix D.

The overall maximum speed limit on both tracks between Framingham and Boston is 60 m.p.h., but there are several 55 m.p.h. sections on curves. For the first half mile east of Framingham there is a 30 m.p.h. limit. On the single track past the Beacon Park freight yards the speed limit is 50 m.p.h. From the east end of the yards to Yawkey Station the speed limit is 40 m.p.h., and from there to just east of Back Bay Station it is 30 m.p.h. For the remainder of the distance to South Station there is a 15 m.p.h. limit. Trains must also operate at greatly reduced speed when crossing from one track to the other.

Estimated Running Times from Framingham Station to Boston for I-290 Trains

At present, peak-period scheduled running times between Framingham Station and South Station in Boston for trains stopping at all intermediate stations range from 47 to 50 minutes, with an average of 48.5. Differences among scheduled times are attributable mostly to differences in expected passenger volumes and station dwell times. With the present speed limits and rolling stock, there is almost no slack in the schedules, so a train from I-290 would also require about 48 minutes to run from Framingham to Boston if stopping at all intermediate stations. Combined with the estimated running times to Framingham from stations on the extension, this would result in travel times too slow to capture much of the market. Therefore, it is assumed for purposes of analysis that I-290 trains running in the peak direction during peak hours would either run non-stop between Framingham and Back Bay or would serve a very limited number of intermediate stops.

At present, the fastest scheduled train time between Framingham and South Station in either direction is 35 minutes, for trains making no intermediate stops between Natick and Back Bay. This could theoretically be reduced to just over 30 minutes for a train running non-stop between Framingham and Back Bay, but coordination with schedules of other trains could necessitate longer times. Each intermediate stop would add about two minutes to the schedule.

Estimated Running Times Between Framingham Station and Boston for Reverse-Commuting Trains

Reverse-commuting trains would need to make some intermediate stops between Back Bay and Framingham in order to serve passengers going to work locations on the I-290 extension from suburban origins. To coordinate the schedules of I-290 trains with those of other present or planned trains on the main line, it would be necessary for all of the reverse-commuting trains in the A.M. peak and some in the P.M. peak to use Track 1 on the inner half of the line. This would preclude stopping at any of the stations in

Newton with their present platform configurations. Potential reverse-commuting boardings alone would be insufficient to justify adding platforms on Track 1 in Newton.

It would also be necessary to limit the number of stops served by reverse-commuting trains on the outer half of the line to avoid delaying peak-direction trains. For purposes of analysis, it is assumed that the only stations served would be Wellesley Square and Natick. For trains serving these stations, the fastest feasible running times between Framingham and South Station would range from about 34 to 37 minutes, with the differences resulting from coordination with schedules of other trains. Stopping at West Natick instead of Natick or at Wellesley Hills or Wellesley Farms instead of Wellesley Square would not change running times significantly. To avoid confusion, however, and to allow those parking at stations maximum flexibility in returning to their vehicles, all reverse-commuting trains should serve the same intermediate stations.

Comparisons with Travel Times for Present Alternatives

Table 3-1 compares estimated travel times to Boston from stations on an I-290/Northborough commuter rail extension with present driving times and scheduled bus times from communities that would be in the extension service area. (These comparisons do not include access times to boarding stops or egress times from alighting stops.) Multiple travel time runs have not been conducted recently over the full lengths of the driving routes to Boston from towns in the I-290 extension corridor, but have been done on the limited-access highway segments most likely to be included in such trips.

Current schedules for limited-stop buses using local roads in the area give an indication of traffic speeds on access routes to the main highways. The fastest driving routes to Boston (though not always the shortest) from all communities served directly by the extension would include use of the Massachusetts Turnpike from Interchanges 12 or 13 in Framingham or 11A (Route I-495) in Hopkinton.

As shown in Table 3-1, train travel times to South Station from the two outermost stations on an I-290 extension would be 5 to 6 minutes (or 11% to 12%) longer than driving times if the train made no intermediate stops between Framingham Station and Back Bay. From the Framingham Rte 9 & 90 station, train time would be 3 minutes (8%) longer than driving times. The only extension station from which train time to South Station would be faster than driving would be Framingham Centre/Salem End Road. From there, the train would have a 4-minute (10%) advantage.

For passengers going to the Back Bay area, the driving time advantage over train time would be about three minutes less than that at South Station. Results of the 1993 MBTA commuter rail survey show that about 56% of passengers who rode from Framingham Station to Boston went to South Station and 44% to Back Bay.

Table 3-1
Comparison of Minimum Running Times to South Station
From Stations on I-290 / Northborough Extension
With Present Bus and Auto Times

Station	Commuter Rail Extension	Scheduled Bus Time	Estimated Driving Time
Northborough / I-290 (Colburn St.)	56 minutes	80 minutes	50 minutes
Marlborough / I- 495 (D'Angelo Drive)	49 minutes	75 minutes	44 minutes
Framingham Rtes 9 & 90 (California Ave.)	39 minutes	53 minutes	36 minutes
Framingham Centre Salem End Road)	35 minutes	55 minutes	39 minutes

Train times are based on non-stop running from Framingham Station to Back Bay. with diesel locomotive and coaches.

Differences in proximity to main highways result in bus or auto times from some stations being equal to or longer than times from some stations further from Boston.

Bus times shown are from the present stops nearest to assumed commuter rail station locations.

Any intermediate stops served east of Framingham would increase running times from extension stations by about two minutes per stop. (For a train stopping at every station between Framingham and Boston, running times would be 17 to 20 minutes longer than shown in Table 3-1.) Likewise, adding one station on the extension would increase running times by about two minutes from stations further from Boston, and eliminating one extension station would reduce running times by about two minutes from stations further out.

At present, there is through bus service to South Station or the South Station area from all of the cities and towns that would have stations on an I-290 commuter rail extension. In Framingham, both of the rail stations would be near bus stops on Route 9. In Northborough and Marlborough the bus stops are in the town centers but the rail stations would be along highways on the outskirts. All of the bus service is relatively infrequent, with one to three trips inbound in the A.M. peak and outbound in the P.M. peak. As shown in Table 3-1, scheduled bus times are also much longer than either driving times or projected rail times. Largely because of the slow and infrequent service, the bus routes capture very small percentages of the ridership market.

The slow running times for the present bus routes are a result of long collection segments at the outer ends and distribution segments at the inner ends. For example, all of the bus routes require 10 to 20 minutes to travel from the Back Bay area to the

South Station area over city streets, but driving time to South Station via the Mass. Turnpike is only about two minutes longer than that to Back Bay. A bus starting at one of the commuter rail station sites and running non-stop to South Station would be able to attain travel times close or equal to those of driving.

Most rail or bus passengers would need travel time in addition to that shown above to get from their actual starting points to their boarding stations or stops and to wait for a train or bus. At the inner trip end additional time would be needed get from the Boston stops or stations to final destinations. The in-vehicle portions of most automobile trips begin at the actual origins and end at parking facilities near the final destinations.

The additional driving times over local streets from the South Station area to parking facilities and walking times on to destinations are analogous to the final distribution links from South Station for rail or bus passengers. The number of final destinations in Boston is, however, too great to permit any meaningful comparisons of distribution times for different travel modes.

In many cases, the fastest driving route to Boston would not run directly past the rail station nearest the trip origin. Survey results and direct observations show that on present MBTA commuter rail lines, the average passenger arrives at the outer boarding station five to seven minutes prior to train departure time. For both of these reasons, comparisons such as those in Table 3-1 that are based on in-vehicle times from stations understate overall driving time advantage.

In summary, most potential users of an I-290 commuter rail extension would find the fastest probable train times to be significantly better than those of present bus service, but would not perceive train times as an improvement compared with driving. Therefore, riders would need to be attracted by considerations other than travel time savings.

Levels of Service

The amount of service operated on existing MBTA commuter rail lines varies among routes. Service on an I-290 extension, as on other lines, would be adjusted over time on the basis of ridership experience. The need to coordinate schedules of I-290 trains with those of Framingham and Worcester trains and CSX freight trains (as discussed in chapter 7 and appendix D) would limit flexibility in adjusting frequencies and departure times, however. As owner of the tracks between Framingham Station and I-290, CSX has priority for their use, and is not obligated to allow operation of passenger trains at all.

At present, service at most MBTA commuter rail stations includes four to six trains arriving at the Boston terminals between 6:30 and 9:30 A.M. and three to six trains leaving Boston between 4:00 and 6:00 P.M. As of May 2001, passenger service on the Framingham / Worcester Line included four trains from Framingham and five from Worcester arriving in Boston between 7:00 and 9:30 A.M. Five of these stopped at all

stations between Framingham and Back Bay and four skipped some groups of stations. Between 4:00 and 6:30 P.M. three trains left Boston for Framingham and four for Worcester, with three making all local stops to Framingham, one omitting only Yawkey, and three running non-stop from Back Bay to West Natick or Framingham. There was one intermediate station between Framingham and Worcester, in Grafton.

Tentative schedules for service after completion of three additional stations between Framingham and Worcester (now under construction) call for no further increases in total inbound A.M. peak service compared with the May 2001 schedules, but outbound P.M. peak service may increase slightly. Some changes in specific arrival and departure times and in the groups of stations served by some trains would also occur.

Based on the track configuration between Framingham and Boston, the maximum number of I-290 trains running express between Framingham and Back Bay that could be provided in addition to peak-period Worcester and Framingham trains would be four inbound in the A.M. peak and four outbound in the P.M. peak. It would also be feasible to run at most four outbound reverse-commuting trips to I-290 in the A.M. peak and four inbound return trips in the P.M. peak. To operate I-290 service, it would be necessary for all trains to adhere closely to their schedules to avoid setting off chain-reaction delays of other trains.

The I-290 trains would increase the amount of express service to and from Framingham Station, but in order to prevent express trains from overtaking all-stops local trains, Worcester and I-290 trains would have to depart Framingham only about 5 minutes apart. Therefore, the main benefit of the added service at Framingham would be a reduction in crowding on Worcester trains rather than a greater choice of departure times. The same benefit could be achieved at lower cost by assigning higher capacity train sets to Worcester trips or by running short-turn express trains from Framingham.

The original plans for Worcester service called for the express trains to make no stops between Framingham and Back Bay, but at present all of them stop at West Natick and one inbound train also stops at Natick. After completion of track improvements and the opening of all four stations between Framingham and Worcester, scheduled running time on that segment is expected to increase to about 34 minutes from the present 30. This could be offset by having express service at West Natick and Natick be provided by I-290 trains rather than Worcester trains. It would also improve distribution of loadings among trains. Another possibility would be to have I-290 trains provide new express service from one of the stations in Wellesley. As noted above, any intermediate stop between Framingham and Back Bay would add about two minutes to running times from stations on the I-290 extension compared with those shown in Table 3-1.

Fares

MBTA commuter rail lines have a zone fare system. Zone limits are based nominally on mileage from Boston, but exceptions are made for reasons such as avoiding different fares at stations in the same town. Fare-payment options include single-ride or 12-ride

tickets and monthly passes. (Survey results indicate that passes are used for an average of about 21 round-trips, or 42 rides, per month.) Senior citizens, children under the age of 12, high school or younger students, and persons with disabilities, are eligible for half fares. Table 3-2 compares the cost per ride to Boston on existing mass transit services used by residents of the I-290 / Northborough rail extension corridor with fares that riders would pay on the extension. Fares at extension stations are assumed to be the same as those from stations at similar distances from Boston on existing commuter rail lines. These fares are described in greater detail below.

Based on track distance from Boston, an I-290 / Northborough station would be in Zone 8, a Marlborough / D'Angelo Drive station would be in Zone 7, a California Ave / Rte 9 & 90 station would be in Zone 6, and a Framingham Centre station would be in Zone 5. From Zone 8, the respective costs per ride with a one-way ticket, 12-ride ticket, or pass used for 21 round trips per month are $5.00, $4.58, or $3.79. From Zone 7 these costs would be $4.50, $4.13, or $3.64. From Zone 6 they would be $4.25, $3.90, or $3.45. From Zone 5 they would be $4.00, $3.67, or $3.24.

Based on present practice, there would be a parking fee of at least $1.00 per day at any station on an I-290 extension route. For a passenger driving alone to the station, this would effectively add 50 cents to each of the one-way trip costs listed above. Passengers using passes could transfer to any connecting MBTA rapid transit, bus or light rail line at no additional charge, but one-way and 12-ride ticket users would not get any discounts on transfers.

Comparisons with Fares for Present Transit Alternatives

Commuter Rail

Among residents of cities and towns that would be served directly or indirectly by an I-290 / Northborough commuter rail extension, the most commonly used mass transit alternatives for travel to Boston or Cambridge are the South Side commuter rail lines. The total numbers of transit riders originating in individual communities in the service area other than Framingham are relatively small, however. Boarding stations vary by community of origin. According to the combined results of the 1993 commuter rail survey and the 1995 Worcester Station survey, 7 of the 9 Northborough residents (78%) who used commuter rail boarded at Framingham Station. This station is in Zone 5, compared with Zone 8 for an I-290 / Northborough station. Depending on fare payment method, Northborough riders diverted to the extension from Framingham Station would pay 17% to 25% higher fares by boarding in their hometown. The two Northborough riders who boarded at Worcester Station in Zone 9 would have an average fare reduction of 9% if they shifted to the I-290 Northborough station.

Among Marlborough residents who used commuter rail, the survey showed that 54% boarded at Framingham Station. If they shifted to the Marlborough / D'Angelo Drive station in Zone 7, their fares would increase by about 12.5%. The rest of the commuter rail boardings by Marlborough residents were scattered among several stations in zones

2, 3, and 4 on the Framingham / Worcester and Fitchburg commuter rail lines. For these riders, the fare increases resulting from shifting to a station in Marlborough would range from 29% to 64%.

Among Southborough residents who used commuter rail, the survey showed that 88% boarded at Framingham Station. If they shifted to a Route 9 & 90 station in Framingham in Zone 6, their fares would increase by about 7%. The rest boarded at West Natick in Zone 4. Their fares would increase by about 22% as a result of shifting to a Zone 6 station. One of the new commuter rail stations soon to be constructed on the Framingham / Worcester line will be in Southborough, and will also be in Zone 6. Southborough residents would be likely to choose between the two stations on the basis of convenience of access, parking availability, and train running times to Boston.

Among Framingham residents who used commuter rail, the survey showed that 73% boarded at Framingham Station. An I-290 extension station in the vicinity of Framingham Centre would be in Zone 5, the same as Framingham Station, but a California Ave. / Rte 9 & 90 station would be in Zone 6. The fare increase for riders diverted from Framingham Station to California Ave. would be 7%, the same as for diversions of Southborough riders. Another 20% of Framingham commuter rail riders boarded at one of the Zone 4 stations in Natick. Most of these riders reported origins on the east side of the town, from which access to West Natick or Natick was at least as convenient as that to Framingham Station. These riders would have little reason to shift to use of a Framingham Centre Station, as doing so would result in both longer access times and longer on-train times. If they did shift, their fares would increase by 14%.

The other 7% of riders originating in Framingham had boardings scattered among several stations in zones 2, 3, and 4 on the Framingham / Worcester and Fitchburg lines. These riders chose their stations for a variety of reasons specific to their transportation needs. Minimizing station access time was evidently not a major concern for them, so convenient access to a Framingham Centre station would be unlikely to outweigh the higher fares there.

As discussed in chapter 2, most of the users of an I-290 extension with trip origins outside of the four cities and towns located directly on the extension route would start from one of ten other nearby towns. As shown in Table 2-1, relatively few commuter rail trips originated in these towns at the time of the 1993 and 1995 surveys.

Ashland had the largest number, with 176, including 118 boardings at Framingham Station in Zone 5. If the latter passengers were diverted to the I-290 extension, they would most likely use the station at Framingham Centre, also in Zone 5, which would not have any effect on their fares. The other 58 commuter rail trips from Ashland were scattered among many boarding stations in Zones 3 and 4. These riders would have their fares raised by 14% to 33% by shifting to the Framingham Centre station. The new station in Ashland on the Framingham / Worcester Line will be in Zone 6. Passengers boarding at Framingham Centre instead of Ashland would save 6% on fares.

Sudbury had the second-largest number of commuter rail trip origins among towns in this group, at 96. The largest share of these at any one station was 67 at Lincoln on the Fitchburg Line in Zone 4. If the latter passengers were diverted to the I-290 extension, they would most likely use the station at Framingham Centre, in Zone 5. This would raise their fares by 14%. The other 29 commuter rail trips from Sudbury were scattered among many boarding stations in Zones 2 through 6. For these riders, changes in fares from shifting to Framingham Centre would range from a 6% reduction for those shifting from Zone 6 to a 45% increase for those shifting from Zone 2.

Shrewsbury had the third-largest number of commuter rail trip origins among towns in this group, at 53, including 41 boardings at Worcester Station in Zone 9. If the latter passengers were diverted to the I-290 extension, they would most likely use the I-290 station in Zone 8, which would reduce their fares by an average of 9%. The other 12 commuter rail trips from Shrewsbury were scattered among many boarding stations, mostly in Zone 5 or closer to Boston. These riders would have their fares raised by 17% or more by shifting to the I-290 station.

Westborough had the fourth-largest number of commuter rail trip origins among towns in this group, at 48, including 31 boardings at Framingham Station in Zone 5. If the latter passengers were diverted to the I-290 extension, they would most likely use the Route 9 & 90 station, also in Framingham but in Zone 6. This would increase their fares by 6%. The other 17 commuter rail boardings from Westborough were scattered among many stations in Zones 3 through 9. For Zone 9 riders, shifting to Route 9 & 90 would reduce fares by 14% to 26% depending on payment method. Shifting from Zone 3 to Route 9 & 90 would raise fares in each category by 42%. The new station in Westborough on the Framingham / Worcester Line will be in Zone 7. Passengers boarding at Route 9 & 90 instead of Westborough would save 5% on their fares.

Bolton, Clinton, and Hudson each had 20 to 25 commuter rail boardings in the surveys, with 82% of these occurring at stations in Zone 5 or Zone 6. Lancaster had 16 commuter rail boardings, with 69% of these in Zone 6. For trips from these towns, the most convenient access to an I-290 extension would be at a D'Angelo Drive / Marlborough station, in Zone 7. Therefore, the majority of the survey riders would pay higher fares if they shifted to the extension.

Of the other two towns served indirectly by an I-290 extension, Berlin had no survey trip origins. Boylston had only three, including two at Worcester and one at Framingham. Extension riders from Boylston would be most likely to use the I-290 station. Riders from Berlin would split between the I-290 and D'Angelo Drive stations depending on origin point within the town.

Express Bus

All four cities and towns in which an I-290 extension would be located have some through express bus service to Boston, with levels of service ranging from one to four inbound A.M. peak or outbound P.M. peak trips. Passenger counts and surveys

conducted in 2000 show that these routes carry about five inbound peak riders from Northborough, 30 to 35 from Marlborough, 25 from Southborough, and 40 from Framingham.

It should be noted that the fare comparisons below do not include costs of connecting services or of parking. Commuter rail pass users would be able to transfer free to MBTA bus and subway service in Boston, but users of all other forms of payment on either private buses or commuter rail would have to pay separate fares to transfer. Based on present practice, passengers parking at commuter rail stations would have to pay at least $1.00 a day in addition to fares, but many bus riders can park free on streets or in shopping centers.

From Northborough, the bus fare depends on boarding location and ranges from $4.65 to $5.00 with a one-way ticket, or $4.23 to $4.25 with an 11-ride ticket. Passengers shifting from this bus to a commuter rail station in Northborough would pay up to 8% more for a single ride, but would save about 11% by switching from an 11-ride bus ticket to a monthly rail pass. (This does not include savings on connecting MBTA services for pass users or differences in parking fees for the two services.)

Bus service from Marlborough is provided by two different companies on two different routes. On one route the fare to Boston is $3.75 with a one-way ticket, or $3.38 with a 10-ride ticket. On the other route, the fare depends on boarding point and ranges from $4.40 to $4.65 with a one-way ticket, or from $4.00 to $4.23 with an 11-ride ticket. Passengers shifting to a Marlborough commuter rail station from the bus route with lower fares would pay 20% more for a single ride, or 8% more by switching from a 10-ride bus ticket to a monthly rail pass. Passengers diverted from the bus route with higher fares would save at most 3% on a single ride, but up to 14% by switching from an 11-ride bus ticket to a monthly rail pass.

Bus service from Southborough is also provided by two different companies on two different routes, but only one had any passengers boarding there in the 2000 counts. The fare to Boston on that route is $3.25 with a one-way ticket or $2.93 with a 10-ride ticket. Passengers shifting from this bus to the Route 9 & 90 commuter rail station in Framingham would pay 31% more for a single ride and 18% more by switching from a 10-ride bus ticket to a monthly rail pass. (This does not include savings on connecting MBTA services for pass users.)

All of the bus service from Northborough, Marlborough, and Southborough to Boston currently receives some funding through the MBTA Interdistrict Transportation Service Program. In cases where bus fares would exceed rail fares from the same town, it would be possible to adjust the subsidy to allow the buses to have the same fare structure that a rail extension would have.

Bus service from Framingham is provided by two different companies on two different routes. On one route the fares to Boston are the same as given for Southborough above, but the only Framingham stop is near California Avenue. Passengers shifting to a

California Avenue / Rte 9 & 90 commuter rail station from this route would experience the same changes in fares as Southborough riders. The other route includes a stop near Framingham Centre as well as one near California Avenue. On that route, the fare to Boston is $5.95 one way, $5.00 with a 10-ride ticket, $4.75 with a 20-ride ticket, or $4.37 with a 40-ride ticket. Passengers diverted from that bus route to a California Avenue / Rte 9 & 90 station would save 28% on a single ride or 21% by switching from a 40-ride bus ticket to a monthly rail pass.

Passengers shifting to a Framingham Centre / Salem End Road commuter rail station from the bus route with lower fares would pay 23% more for a single ride, or 11% more by switching from a 10-ride bus ticket to a monthly rail pass. Passengers diverted from the bus route with higher fares would save 33% on a single ride or 26% by switching from a 40-ride bus ticket to a monthly rail pass.

The rail fare to Boston from a Framingham Centre / Salem End Road station would be the same as that from the present Framingham Station. Most public transportation users from the Framingham Centre area now travel the two miles from there to Framingham Station to take the train rather than using the bus route that serves Framingham Centre directly. Therefore, few people would actually experience the fare savings described above.

Table 3-2
Cost per One-Way Trip to Boston for Selected Rail and Bus Fare Options
(Fall 2000 Fares)

	Origin Town								
	Northborough			Marlborough			Southborough		
Alternative	One-Way	12-Ride	Pass	One-Way	12-Ride	Pass	One-Way	12-Ride	Pass
Rail Extension Station									
Northborough / I-290	$5.00	$4.58	$3.79						
Marlborough / I-495				$4.50	$4.13	$3.64			
Framingham Rte 9 & 90							$4.25	$3.90	$3.46
Existing Service									
Commuter Rail									
Framingham	$4.00	$3.67	$3.24	$4.00	$3.67	$3.24	$4.00	$3.67	$3.24
West Natick or Lincoln				$3.50	$3.21	$2.83	$3.50	$3.21	$2.83
Waltham				$2.75	$2.52	$2.24			
Express Bus to Boston	$5.00	$4.55		$3.75	$3.38		$3.25	$2.93	

Notes: Costs shown above exclude parking fees.
Commuter rail passes provide free transfers to connecting MBTA services.
Multiple-ride fare comparisons for express bus are based on 10-ride tickets from Marlborough or Southborough or 11-ride tickets from Northborough.

Potential Commuter Rail Market Groups

Boston and Cambridge Work and Non-Work Trips

Based on the travel patterns on the existing Boston commuter rail system, the vast majority of riders on an I-290/Northborough extension would use the service for peak-period work trips to Boston or Cambridge. The 1993 commuter rail survey found that among riders of lines terminating at South Station, 97% of those specifying their destinations were destined for points in either in either Boston or Cambridge, and 90% of these were making home-to-work trips. Otherwise stated, home-to-work trips ending in these two cities accounted for 87% of all South Side commuter rail ridership. Over 95% of the home-to-work trips on South Side commuter rail lines were made on trains scheduled to arrive at South Station between 6:30 and 9:30 A.M.

On the Old Colony lines, which opened in 1997, a 1998 survey found Boston and Cambridge home-to-work trips accounting for 78% of total ridership. This lower proportion compared with the older lines was largely a result of unusually high interzone ridership, with most such trips being destined for points in Quincy.

For rail trips now originating in cities and towns that would be served by an I-290 extension, Boston and Cambridge work travel is similar to that for total ridership on the older South Side lines. In the combined 1993 and 1995 surveys, 99% of the respondents with origins in Northborough, Marlborough, Southborough or other service area towns shown in Table 2-1 (excluding Framingham) were traveling to Boston or Cambridge. Of these, 91% were making home-to-work trips, with a range of 85% to 100% among the origin cities and towns. Otherwise stated, home-to-work trips ending in Boston or Cambridge accounted for 90% of the commuter rail trips from the 13 selected origins. The slightly lower-than-average percentages of trips to destinations other than Boston or Cambridge and trips for purposes other than travel from home to work are consistent with the lack of direct commuter rail service in any of the 13 communities.

Within Boston, the present commuter rail market share is highest for trips ending in Boston Proper, defined approximately as the area bounded by Massachusetts Avenue, the Charles River, Boston Harbor, Fort Point Channel, and the Southeast Expressway. The 1993 survey found that 90% of the Boston work trip destinations on South Side commuter rail lines were in Boston Proper. (Among I-290 extension direct service area communities, the figure was 89%.) In the 1998 Old Colony survey, 87% of work trips to Boston ended in Boston Proper. In contrast, 1990 Census figures showed that only about 55% of *total* Boston work trip destinations (including all modes of travel) from the cities and towns served directly or indirectly by South Side rail lines were in Boston Proper.

In the 1993 survey, rail work trip destinations in Boston locations outside Boston Proper were concentrated most heavily in neighborhoods bordering on Boston Proper with

92% of those from South Side lines going either to the Fenway / Parker Hill area, South Boston, or Charlestown. For the Framingham / Worcester Line alone, the corresponding figure was 79%, with Allston / Brighton and North Dorchester together accounting for another 12%. For the Old Colony Lines in 1998, Fenway / Parker Hill / BU, South Boston, and Charlestown attracted 86% of the work trips to points in Boston outside Boston Proper.

Other Destinations and Trip Purposes

Work trips account for a much higher proportion of commuter rail trips destined for Boston or Cambridge than of those destined for other locations. In the 1993 survey results, of the 5% of South Side rail trips with destinations outside Boston or Cambridge, only 40% (or 2% of the total ridership) were work trips. In the Old Colony survey, 62% of the trips to destinations outside Boston or Cambridge were work trips.

On the older South Side rail lines, among trips with destinations outside Boston or Cambridge, the majority involve traveling into Boston and transferring from commuter rail to other modes. Such trips accounted for 2.3% of the total in the 1993 survey. The Old Colony figure in 1998 was only slightly higher, at 2.4%.

Interzone ridership (i.e. trips between two stations on the same line excluding South Station, Back Bay, or stations in fare zone 1A or 1B) accounted for under 1% of weekday trips in 1993. This was partly a reflection of the locations of rail stations relative to suburban trip attractions rather than of inherent unattractiveness of commuter rail for suburb-to-suburb travel. As detailed further in appendix H, interzone ridership possibilities specific to an I-290 extension were analyzed. It was concluded that interzone travel on this line would account for about 5% of its total traffic.

On the present MBTA commuter rail system, most reverse-commuting service is incidental to Boston-oriented service, and ridership is low. The Marlborough Transportation Task force is advocating implementation of the extension in part as a means of providing transportation to jobs in industrial and office parks located along the extension. An analysis of train running times and available time slots indicates that at least one outbound A.M. peak and one inbound P.M. peak train would be likely to be provided as by-products of Boston commuting service, and that it would be feasible to operate up to four outbound A.M. peak trains and four inbound P.M. peak trains if the demand justified this level of service. With more than one reverse-commuting trip, however, it would be necessary to increase the number of passing sidings or double-track sections on the extension.

Summary of Demand Estimation Method

Ridership forecasts for an I-290 / Northborough extension were prepared using a manual forecasting method described below and in appendix H. Separate forecasts prepared using the CTPS regional demand model showed ridership levels similar to those of the manual method, but with some differences in distributions of boarding

locations and trip origins. The manual forecast results were used in most of the analysis in this study, because they were based on a more in-depth examination of conditions specific to this corridor. (The model-based forecasts are discussed further at the end of this chapter.) Total work travel from each town in the extension corridor to Boston Proper, the rest of Boston, and Cambridge was estimated from the most recent U.S. Census Journey-to-Work reports, with adjustments for subsequent changes in population and employment, and the influence of the extension itself on these. Estimates of the shares of this travel that an I-290 extension could be expected to capture were made on the basis of information for existing commuter rail lines in the Census reports and in surveys of existing MBTA commuter rail lines.

Non-work travel to Boston and Cambridge destinations via an I-290 extension was estimated by adding factors derived from survey results to the work trip estimates. Ridership to destinations beyond Boston and Cambridge was likewise estimated by applying factors to Boston and Cambridge ridership. Interzone and reverse-commuting travel was estimated on the basis of an analysis of trip attractions within the corridor and the convenience of rail service for reaching them.

The most recent Census Journey-to-Work data available for use in conjunction with the Boston and Cambridge ridership forecasts were collected in 1990. In the manual forecasting method, population and employment patterns from that Census were adjusted to reflect expected changes as of the years 2000 and 2020. The adjustment factors used were based on a combination of data from the Census Bureau, MAPC, and the Massachusetts Institute of Social and Economic Research along with estimates of the maximum percentages of service area residents likely to work in Boston or Cambridge.

Results of the 2000 U.S. Census show that overall population in the I-290 extension service area increased by 13.5% between 1990 and 2000.[10] Gains ranged from only 1.6% in Clinton to 32.5% in Southborough. The Census Bureau does not attempt to update Journey-to-Work figures between censuses, and findings for 2000 will not be available until 2002.

As a result of economic conditions, total employment in Boston and Cambridge combined declined by 6.9% from 1990 to 1992. It then began to grow again, but did not surpass the 1990 level until 1996. By 1999 Boston and Cambridge employment was 7.1% greater than in 1990. The 14 cities and towns that would be served directly or indirectly by an I-290 extension also lost jobs in the early 1990s, but had an overall gain of 14.4% between 1990 and 1999. The percentage of residents of the I-290 service area employed anywhere declined slightly, from 55.4% in 1990 to 53.3% in 2000. This was a result of a combination of factors such as increases in the number of children, retirees and people choosing not to work, rather than inability to find jobs. Between 1990 and 2000, each of the 14 cities and towns showed a significant reduction in unemployment, so the overall unemployment rate in this area dropped from 5.0% to 2.0%. The net

[10]Estimates of population changes between decennial U.S. Censuses are prepared at two-year intervals. The next update will be for the year 2002, but will not be available until late 2003.

result of employment changes was an increase of 9.2% in employed residents compared with the 13.5% population gain.

In absolute terms, the net increase in employment within these municipalities between 1990 and 1999 (the most recent year for which total employment figures by town are available) was about 1.7 times as great as their increase in resident labor force.

The alternatives available for travel to Boston or Cambridge from the I-290 extension service area were about the same in 1998 as in 1990. Commuter rail service from Framingham was improved with the addition of Worcester express trains, but bus service was cut back significantly. Given this, and the greater rate of growth in employment opportunities within the extension service area, it would not be expected that home-to-work trips to Boston or Cambridge from most of the 14 municipalities would have increased at much higher rates than their population gains between 1990 and 2000.

New housing construction in the extension service area and rising housing prices closer to Boston would be expected to lead to increases in the number of Boston and Cambridge work trips from the service area in future years, but at the same time there will be increased opportunities for employment at suburban locations. Therefore, with the added travel option of an I-290 extension, the percentage of residents in an individual city or town in its service area employed in Boston and Cambridge would be expected to fall within the observed range for communities at similar distances from Boston on the present commuter rail system.

Ridership Forecasts by Trip Purpose and Destination

Ridership forecasts using the methods described above were prepared for several different operating scenarios, ranging from a limited schedule with service consisting only of inbound A.M. peak and outbound P.M. peak weekday trains to all-day service include reverse-commuting schedules and weekend trains.

The alternative with the most service would attract the greatest number of riders, but (as discussed in chapter 6) it would also have the highest operating cost and the highest operating subsidy requirement. This alternative would provide 17 weekday round trips, including four outbound A.M. peak and four inbound P.M. peak trips scheduled for reverse commuting. At year 2000 demand levels, an estimated 2,160 riders each way would use this service. Of these, 340 would board at the I-290/Northborough terminal, 530 at a D'Angelo Drive/Marlborough station, 535, at A Route 9 & 90 station in Framingham and 720 at a Salem End Road station in Framingham Centre. The other 35 would be riders who would use extension trains at Framingham Station, but would not use the existing service there.

Of the 2,160 inbound riders, about 1,545 would be making work trips from home to destinations in Boston or Cambridge. Another 260 would be going to Boston or Cambridge for non-work trips. About 40 would be continuing to other destinations

beyond Boston for purposes other than returning home from reverse-commuting trips. Reverse-commuters returning from school or work to destinations in or beyond Boston or Cambridge would account for about 185 trips, and reverse-commuters returning to points before Boston (i.e. interzone destinations) would account for about 60. The other 70 riders would be making interzone trips other than returns from reverse-commuting. With projected changes in population, and probable changes in the proportions of town residents working in Boston or Cambridge, ridership would increase to about 2,730 each way per day by 2020.

With reverse-commuting schedules limited to trains that would be operated anyway as by-products of peak-direction service, there would most likely be only one outbound A.M. peak trip and two inbound P.M. peak trips, and these would not be at times convenient for the majority of reverse commuters. At year 2000 travel levels, this would reduce the total number of reverse commuters from about 240 each way to about 50, and total inbound boardings to 1,970. The total number of trains operated would drop to 12 round trips on weekdays.

The minimum level of service considered for analysis was three inbound A.M. peak and three outbound P.M. peak trains, with no off-peak or off-direction service. Based on the proportion of ridership on present MBTA commuter rail lines served during peak hours and the number of peak trains operated, and allowing for the fact that some passengers ride peak trains in one direction but off-peak trains in the other, this minimum level of service would be used by about 1,055 riders each way per day. It is unlikely, however, that such a low level of service would be provided as a long-range strategy. Although some recent extensions such as the Worcester and Old Colony lines have opened with only peak-period, peak-direction service, off-peak service was subsequently added. All MBTA commuter rail lines currently have at least some midday and evening trains.

Estimated Ridership by Town of Origin

Tables 4-1 and 4-2 show the outer endpoints of trips in the demand estimates at year 2000 levels and in the year 2020. The latest MAPC projections for 2020 compared with Census totals for 2000 indicate that combined population in the 14 cities towns in the extension service area will increase by about 9.2% in that time span. Individual gains are expected to range from 1.1% in Framingham to about 41.0% in Bolton, but most of the 14 would have increases of under 16.0%.

Estimated Ridership Diversions from Other Transit Services

New commuter rail extensions typically draw large percentages of their riders from other transit services. For example, a survey of riders using the Old Colony lines one year after opening found that 55% had previously made the same trips on other mass transit services. Another 19% had not previously made the same trips by any means. This included some with coincidental changes in their travel needs that would have resulted in use of other mass transit if the Old Colony lines had not been available. Some of those who switched to the Old Colony lines did so because of service cutbacks

Table 4-1
Estimated Weekday Inbound Ridership on I-290 Extension
by Town of Origin at Year 2000 Travel Levels

City or Town	Limited Weekday Peak Service	Full Service with Limited Reverse Commute	Full Service with Maximum Reverse Commute
Framingham	305	590	690
Southborough	65	120	120
Marlborough	280	525	605
Northborough	115	210	220
Hudson	50	90	90
Berlin	5	10	10
Boylston	10	20	20
Shrewsbury	35	65	65
Bolton	15	25	25
Clinton	35	65	65
Lancaster	10	15	15
Ashland	15	25	25
Sudbury	85	155	155
Westborough	30	55	55
Total	1,055	1,970	2,160

Table 4-2
Estimated Weekday Inbound Ridership on I-290 Extension
by Town of Origin at Year 2020 Travel Levels

City or Town	Limited Weekday Peak Service	Full Service with Limited Reverse Commute	Full Service with Maximum Reverse Commute
Framingham	335	640	750
Southborough	85	160	160
Marlborough	365	685	790
Northborough	165	305	320
Hudson	75	140	140
Berlin	10	15	15
Boylston	10	25	25
Shrewsbury	55	100	100
Bolton	20	35	35
Clinton	50	90	90
Lancaster	15	25	25
Ashland	20	35	35
Sudbury	95	170	170
Westborough	40	75	75
Total	1,345	2,500	2,730

on their prior alternatives, but most switched by choice. It is not an unreasonable objective to provide present transit users with improved service, but the net impacts on revenue, on reduced highway congestion, and on improved air quality are much smaller than they would be if all riders of an extension were new transit users.

Table 2-2 shows the number of passengers from cities and towns in the expected service area of an I-290 extension who were using existing transit services in the most recent available surveys. These figures do not include riders using the Grafton Station which opened in February 2000 on the Framingham / Worcester commuter rail line. The MBTA is constructing additional stations on that line in Ashland, Southborough, and Westborough. All of those stations are expected to be open long before it would be feasible to implement service on an I-290 extension, and they will attract riders from some of the cities and towns in the extension service area. Therefore, estimates of diversions of riders from other transit services must also take into account impacts on the new stations between Framingham and Worcester.

Based on comparisons of several characteristics including access times, on-board times, frequencies, and fares, of the 2,160 riders attracted to an I-290 extension at year 2000 travel levels and maximum service levels, 960, or 44% would be diverted from present MBTA transit services or from new stations on the Framingham / Worcester line. Between 50 and 100 riders on the extension would be people who previously used private-carrier express bus routes. Some of them would otherwise be lost to new stations between Framingham and Worcester, however, and would be included in the 960 figure above. Overall, the proportion of I-290 riders expected to be diverted from other transit services is slightly lower than that found on the Old Colony lines (44% to 50% versus 55%) but Old Colony passengers had a different mix of prior alternatives.

Riders diverted to an I-290 extension from other transit services would free up parking and vehicle capacity on those services. New riders attracted to those services as a result of such freed-up capacity would offset some of the revenue losses resulting from diversions to the extension. It is unclear, however, to what extent potential demand for existing or committed new transit facilities will exceed their capacities, or what means of transportation are currently used by those potential riders. Therefore, it cannot be assumed that all or even any of the capacity freed up by diversions to an I-290 extension from any given facility would be re-filled by new transit riders.

Estimated Weekend Ridership

Most, but not all, MBTA commuter rail lines currently have service on weekends as well as on weekdays. The only exceptions are the Needham Line, which has service on Saturdays but not Sundays, and the Fairmount Line, Stoughton Branch, and Providence Line beyond South Attleboro, all of which have no Saturday or Sunday service.

Weekend ridership is more difficult to predict than weekday ridership, because weekend travel consists largely of non-repetitive trips for purposes such as shopping, sightseeing, attending sporting events, etc. For the commuter rail system as a whole,

1994 data showed that ridership averaged 29.2% as high on Saturdays as on weekdays, and 17% as high on Sundays as on weekdays. These proportions have changed little since then. With ratios similar to these and weekday ridership at the maximum year 2000 travel level estimated in Table 4-1, stations on an I-290 extension would be expected to serve about 630 inbound riders on Saturdays and about 365 on Sundays.

Impacts of I-290 Extension on Main Line Ridership East of Framingham

To provide attractive running times, I-290 extension trains would most likely run non-stop between Framingham and Boston at least in peak hours. Therefore, the only main line station that would have a direct improvement in service would be Framingham. In order to fit I-290 trains into schedules along with all of the other present or planned trains, it would not be possible to coordinate Worcester and I-290 express departures to provide uniform headways at Framingham. Instead, I-290 and Worcester expresses would have to leave Framingham only about five minutes apart. For most potential riders, this would not be perceived as a significant improvement in departure time choice, so the impact on ridership would be small.

The slightly faster running times of non-stop I-290 express trains compared with Worcester express trains stopping at West Natick or Natick would be likely to divert some Framingham boardings to I-290 trains. This would reduce loads on Worcester trains, and could make travel from points west of Framingham more attractive. Shifting express service provision at West Natick and Natick from Worcester trains to I-290 trains would make the I-290 trains the less attractive option for Framingham boardings, but would reduce loads on the Worcester trains by the amount of the West Natick and Natick boardings. None of the impacts discussed above would add significantly to the estimates of new transit ridership attracted by an I-290 extension.

Model-Based Ridership Forecast

In addition to the demand estimates produced by the methods described above and in appendix G, ridership on an I-290 extension was forecast using the CTPS Regional Model. This model is currently being used for all CTPS highway and transit studies within the region. The Regional Model forecasts were made for the years 2000 and 2020, for an alternative that corresponds most closely with the Limited Reverse Commute Service in tables 4-1 and 4-2.

The Model forecast a total of 1,930 inbound boardings at the four extension stations in the year 2000, and 2,365 in the year 2020. The manual method predicted 1,970 boardings in 2000 and 2,500 in 2020. The Model estimates were 2.0% and 5.4% lower than the corresponding manual estimates. A more important difference was in the distribution of boardings. The model predicted a higher proportion of boardings at Framingham Centre and lower proportions at Route 9 & 90 and at D'Angelo Drive than the manual method. Fares would be lower at Framingham Centre than at the other stations, so the distribution in the Model would generate lower revenue. Therefore, the manual results should be regarded as providing upper-bound estimates for revenue.

5. CAPITAL COSTS

The main capital costs for commuter rail extensions consist of construction or upgrading of tracks, signals, bridges, and crossings, construction of station and parking facilities and train layover facilities, and acquisition of rolling stock. An extension from Framingham Station to Route 1-290 in Northborough would use rail lines that are currently used for freight service. The tracks are in only fair condition, however, and would need to be completely rebuilt to make them suitable for passenger service. Capital costs are summarized below and in Table 5-1 by category. All of the capital cost figures presented in this study are approximations. The unit costs used are the latest figures used by the MBTA Planning Department for preliminary analysis of commuter rail extensions. They are based on a combination of recent experience in rehabilitating rail lines in the Boston area and on recent studies including the 1997 New Bedford / Fall River Commuter Rail Expanded Alternatives Analysis.

Track and Signals

As noted above, an I-290 extension would require reconstruction of the existing track. At present the entire line is unsignalized. Freight trains are given clearance to occupy specified sections of the line by orders radioed from a dispatcher. For passenger service operating with frequencies comparable to those on existing MBTA commuter rail lines, an automatic signal system would need to be provided throughout the extension.

Costs for track and signals are related directly to route length. The distance from Framingham Station to Route I-290 in Northborough is 15.7 miles. Track replacement and signal installation for this distance would cost $40,665,000 for one track.

In the past, the maximum extent of double track on the route of the I-290 extension was from Framingham Station to Marlboro Junction, with the remainder having always been single track. All of the second track between Marlboro Junction and Framingham Centre was removed in the early 1930s. The line segment between Framingham Centre and Framingham Station, which is currently classified as part of the North Framingham freight yard, was reduced from double to single track during the Conrail era. The remaining track shifts from the west side of the right-of-way to the east side in a sharp s-curve between Maple Street and Salem End Road. This curve is apparently the result of retention of the best portions of the former two tracks, but it should be eliminated during track reconstruction for passenger service.

With a single track, it would be necessary either to restrict passenger train operation to one direction during peak hours or to operate trains on headways no closer than about 50 minutes. The former strategy would preclude operation of reverse-commuting service, and the latter would require operation of fewer peak-direction trains than are currently run on most MBTA commuter rail lines.

The number of passing sidings required and their lengths and locations would depend not only on train frequencies in each direction, but on the specific departure times

required for coordination with schedules of other trains using the main line between Framingham and Boston. Once the sidings were in place, flexibility to revise schedules of either I-290 extension trains or other trains on the main line would be limited.

With four peak-direction trains in each peak period, any reverse-commuting train scheduled to serve work locations in Northborough, Marlborough, or Framingham would have to pass at least one of the peak-direction trains at some point on the extension, and some would have to pass two. Based on the estimated station locations and running times on the I-290 extension, and on expected schedules of main line trains after full implementation of Worcester service, a passing siding in the vicinity of Salem End Road in Framingham would be needed by a reverse-commuting train on almost any useful and feasible schedule. This siding would be within the area now classified as part of the Framingham North Yard, but outside the area involved in most yard switching operations.

To run trains at times suitable for 9:00 to 5:00 work schedules, a second siding would need to be located just east of the former Marlboro Junction Station site, around Sears Road in Southborough. This is within the former double track segment, so locating a siding within the existing grade should be feasible. To serve other work shifts in addition to 9:00 to 5:00 a third passing siding would be needed. The optimal location for it would be just west of the Northborough / Marlborough border. Part of the track in that area is on a low fill across Little Crane Swamp, however, and the right-of-way there is graded for only a single track. If environmental considerations prevent use of this site, scheduling considerations would require substitution of two additional sidings, one further to the east and the other further to the west.

Each of the passing sidings would need to be at least long enough to clear the longest passenger trains that would ever be run on the line. To allow for rotation of train sets among South Side routes, this would require minimum siding lengths of about 1,000 feet between switch points. With such short sidings, the first train to arrive at a meeting point would need to come to a full stop and wait for the second train to arrive and pass. Longer sidings would allow for greater variation in arrival times, and possibly for non-stop meets. Passing sidings at the sites discussed above are assumed for costing purposes to be 2,000 feet long at Salem End Road and Sears Road and 1.5 miles long at the Marlborough / Northborough line. Much of the expense of constructing a passing siding is for the switches and signals at the ends, and is unaffected by the total length.

Passing sidings at Salem End Road and Sears Road would cost about $2,740,000 each. The combined cost of the two, which would be required to provide minimum reverse-commuting service, would be $5,480,000. A passing siding at the Marlborough / Northborough line, being much longer and requiring widening of the grade, would cost about $5,290,000. The total cost for all three passing sidings (needed for maximum reverse-commuting service) would be $10,770,000.

Between Framingham Station and South Station in Boston, I-290 trains would run on the tracks of the present Framingham / Worcester Line. This line has two tracks except

past the CSX Beacon Park freight yards in Allston, where there is only one through track. On all of the double-track segments, signals allow operation of trains in either direction on either track. Locations where trains can change tracks are CP-21 (just east of Framingham Station), CP-11 (just west of Route 128), CP-4 and CP-3 (at either end of the Beacon Park Freight Yard) and Cove (east of Back Bay). In order to reduce potential delays caused by slow-moving freight trains entering or leaving the west end of the Beacon Park yards, the MBTA Railroad Operations Department recommends that an additional set of crossovers be installed at around milepost 7 east of Newtonville Station. Such crossovers would be of benefit even without an I-290 extension, but would be especially important with the increased train frequency from the extension. The cost of the new crossovers would be about $2,500,000.

Road Crossing Surface, Lights, and Gates

Between Framingham Station and the I-290 station site in Northborough, the I-290 extension route has 12 grade crossings of public roads and two crossings of industrial park roads used by the general public. There are also several infrequently used private crossings, mostly providing access to farms or utility installations. The two public crossings nearest Framingham Station (Maple Street and Salem End Road) and the Route 20 crossing at Northborough Center are protected by automatic two-quadrant gates and flashing lights. The Route 9 crossing at Framingham Centre is protected both by automatic flashing lights and by a set of traffic signals that can be activated manually from controls inside locked boxes.

The other public crossings are protected by automatic flashing lights, but do not have gates. D'Angelo Drive in Marlborough, one of the two most heavily used industrial crossings, also has automatic flashing lights. The other heavily used industrial crossing, California Avenue in Framingham, has stop signs but no lights or gates. Railroad operating procedure there calls for trains to stop before the crossing and for a member of the train crew to flag down traffic before the train proceeds.

For passenger service, automatic gates should be installed at all of the public crossings that do not currently have them, and at California Avenue and D'Angelo Drive. At minimum these should be two-quadrant gates. Four-quadrant gates may be called for at some locations, depending on the results of tests of such devices currently in progress on other rail lines.

The private crossings other than California Avenue and D'Angelo Drive are currently protected only by signs. Most of these are infrequently used, and would not require automatic crossing protection, but some of the signs need to be replaced.

The most hazardous of the private crossings is on a dirt driveway leading into the Marlborough Equestrian Center, at the former Marlboro Junction Station site. This crossing is located within the sharpest curve on the entire extension route, with poor sight lines on both the railroad and the road. The road provides the only vehicular

access to the Equestrian Center. At minimum, this crossing would need to have gates installed, unless it can be replaced with a new access route.

Most of the public grade crossings, and those at D'Angelo Drive and California Avenue, currently have asphalt surfaces with guard timbers on each side of each rail. The surfaces are generally in fair to poor condition and should be replaced with rubberized surfaces for passenger service. The only crossing with a rubberized surface at present is that of Route 9 at Framingham Centre. This is the most heavily used crossing on the line, and the surface there is also in poor condition with many patches. It should also be completely replaced for passenger service.

The total cost of all of the improvements in crossing surface and protection listed above would be about $2,775,000.

Fencing

At present, most of the right-of-way of the I-290 extension route is unfenced. For safety, fencing would be needed at all locations where developed land adjoins the rail line. Fencing would need to extend far enough past each developed area to discourage trespassers from walking around the ends of fences. Based on the extent of development shown in recent aerial photos, this would require a minimum total of about 55,000 linear feet of fencing, at a cost of about $825,000.

Bridges

Between Framingham Station and I-290, there are only three track bridges over roads: one in Framingham and two in Southborough. There are also numerous bridges and culverts over rivers and brooks, and several cattle passes at old farm sites. The longest water crossings are a 74-foot deck plate girder bridge across the Sudbury River and a 55-foot deck plate girder bridge across MWRA Reservoir 3 in Framingham; a 20-foot stone arch over Stony Brook in Southborough; and a 12-foot stone arch over the Assabet River in Northborough.

A detailed examination of all of the bridges and culverts would be needed to determine the amount of upgrading or replacement that would be required for operation of passenger service on the line. A superficial inspection of the bridges indicates that they have received little maintenance in recent years. The 1989 feasibility study (cited on page 1 of this report) included an estimate of $113,000 in 1989 dollars for upgrading of bridges on an extension as far as I-495 in Southborough. To allow for probable further deterioration since then, for increases in construction prices, and for additional bridges between I-495 and I-290, a figure of $1,000,000 for bridge upgrading is included in the cost estimates in the present study. The actual requirement could be higher if more detailed studies reveal more serious problems with the bridges. Based on recent experience on other MBTA rail extension projects, actual cost could reach up to $1,000,000 per bridge.

Ten roads cross the rail line on bridges of various ages and designs between Framingham Station and I-290. Passenger service would not require any improvements to these bridges that would not otherwise be needed to maintain the existing freight service on the line, so no cost for upgrading these bridges has been included here. A superficial inspection indicates that at least two of these bridges need to be rebuilt or replaced in the near future. It would be advisable to do this work prior to the implementation of passenger service to avoid train delays or a prolonged construction schedule.

Station Platforms and Shelters

The stations on an I-290 extension assumed for purposes of analysis would all be at locations where there were never stations in the past. Even if some stations were located at old sites, there are none where usable components of the past stations remain. Therefore, all-new construction would be needed at each site.

The current standard for new MBTA commuter rail stations calls for platforms long enough for nine-car trains. To meet Architectural Access Board requirements, the full platform length must be high-level. Much of the freight traffic on the Fitchburg Secondary Track consists of bulk materials carried in large-dimension covered-hopper or tank cars. The CSX Corporation, which owns the line and operates the freight service, does not permit construction of station platforms on its lines unless they provide adequate clearance for freight trains. This necessitates either provision of separate freight and passenger tracks through station areas or use of mini-high platforms with movable bridge plates to permit access by passengers with disabilities. The latter option requires variances that can only be granted by the Architectural Access Board or through legislative action. There is a precedent for this at new stations west of Framingham on the Framingham / Worcester Line. In the case of Worcester Union Station, the Worcester Redevelopment Authority petitioned for and ultimately secured legislative approval for such a variance.

East of Framingham on the segment that would be shared by I-290 trains, the only accessible station having full high-level platforms rather then mini-high platforms is South Station. Therefore, passengers who needed to use high-level platforms and were traveling between I-290 extension stations and most main line stations would have to ride in only in cars that would stop at mini-high platforms even if extension stations had full-length high platforms.

For the reasons above, stations on an I-290 extension would be likely to have mini-high platforms rather than full high-level platforms. Based on recent unit costs of similar stations, the cost of station platforms and shelters for an I-290 extension with four stations would be about $4,000,000. If it were not possible to obtain a variance for construction of low-level platforms with mini-high platforms, the necessary by-pass tracks for freight trains at each station would result in much greater cost.

Parking

The required parking capacity on an I-290 extension would depend on the service operating strategy and the general station locations. For purposes of analysis, it is assumed in this study that service would include four inbound A.M. peak trains and four outbound P.M. peak trains running non-stop between Framingham and Boston. Stations on the extension would include parking facilities with unconstrained capacity with convenient access from Routes I-290 and I-495, state Route 9, and the Massachusetts Turnpike. Service based on these assumptions would generate the greatest demand for parking of any scenario. Alternatives with longer running times or station sites oriented more toward walk-in or drop-off access would generate lower demand for parking.

As discussed in chapters 2 and 3, because of the location of an I-290 extension relative to other commuter rail lines, most of the ridership would be expected to come from 14 cities and towns on or near the route. Parking spaces at an I-290 / Northborough station would be used predominantly by residents of Northborough, with additional ridership being drawn from Shrewsbury, Clinton, Boylston, and Berlin. Parking at an I-495 / Marlborough station would be used predominantly by residents of Marlborough, with additional ridership from Hudson, Clinton, Bolton, Lancaster, and Berlin. Parking at a California Avenue / Route 9 & 90 station would be used predominantly by residents of Marlborough, Southborough, Framingham, and Westborough, with smaller numbers coming from scattered origins along the Mass. Turnpike corridor. Parking at a Framingham Centre / Salem End Road station would be used mostly by residents of Framingham, Sudbury and Ashland. Each station would also draw a few riders from other towns not listed above, but the number from any such individual town would be too small to predict separately.

The outer three stations on the extension would be within walking distance of small numbers of homes, not all of which would be occupied by potential rail users. Therefore, most of the riders at these stations would arrive in vehicles that would need all-day parking capacity. A Framingham Centre Station would be in an area with much greater residential density than that around any of the outer three stations, but would also attract many of its riders from beyond walking distance.

Parking facilities at most present MBTA commuter rail stations consist of open surface lots. Garages are usually used only in locations where density of surrounding development precludes construction of surface lots large enough to meet demand. Decking over of surface lots to provide a second parking level has been proposed in a few cases, but has not yet been implemented in any of them. The added construction cost of a garage or deck typically outweighs the added real estate cost of surface parking.

Actual design of parking facilities is beyond the scope of this study, but for reasons cited above, it is assumed that parking at the two outer stations would be provided in

surface lots. Because of greater land constraints at California Ave./Route 9 & 90 and Framingham Centre, parking at those stations might include decks or garages.

With year 2000 demand levels, allowing for daily variation in ridership, an I-290 extension would require a total of 1,575 parking spaces. With surface parking at all stations, the cost for this number of spaces would be about $6,610,000. A garage instead of surface parking at Framingham Centre would increase this cost to $11,660,000. Garages at both Framingham Centre and Route 9 & 90 would increase this cost to $16,460,000.

With the ridership increases predicted by the year 2020, parking capacity would need to be expanded by an additional 25%. Compared with requirements at year 2000 travel levels, the additional 400 spaces needed by 2020 would increase construction cost to $8,260,000 with all surface parking, $14,575,000 with a garage only at Framingham Centre, or $20,575,000 with garages at both Framingham Centre and Route 9 & 90.

The costs above do not include expenses for real estate acquisition. In most cases, the MBTA must pay appraised market value for parking facility sites. Values depend on present uses of the sites and on the amount of demand for the same sites for other uses. Based on recent experience, acquisition of sites large enough to provide parking for year 2000 demand levels at all stations on the extension would cost about $3,350,000. To meet year 2020 parking demand, this would increase to $4,425,000.

If the minimum frequency of only peak-direction peak-period service were to be operated as a long-term strategy, the lower demand would require smaller parking capacity. This would reduce the cost of all-surface parking to about $3,500,000 for construction and $1,790,000 for land acquisition at year 2000 demand levels. At year 2020 levels these would increase to about $4,415,000 and $2,240,000.

Rolling Stock

Rolling stock requirements for an I-290 extension would depend on the number of trips operated each day, the strategy used for coordinating I-290 service with existing Framingham/Worcester Line service, and the kind of equipment used. Chapter 6 discusses operating costs for several alternatives using push-pull trains similar to those now used throughout the MBTA commuter rail system and for other alternatives using trains of Diesel Multiple-Unit (DMU) cars. Rolling stock costs attributable to the extension would include acquisition of equipment that would be needed to operate the commuter rail system with the extension but would not be needed without it. In 2001, new diesel locomotives comparable to those used on existing MBTA commuter rail lines cost about $3,000,000 each. Double-deck coaches similar to those in the present MBTA fleet cost about $2,335,000 each. Costs for DMUs are less certain, since none have been built recently for U.S. applications. The 1997 New Bedford/Fall River Expanded Alternatives Analysis assumed that the cost of a single-level DMU would be about 40% greater than that of a double-deck locomotive-hauled coach, With the same ratio, the cost of a DMU in 2001 would have been about $3,240,000. This cost could vary,

depending on the specific car model selected, and the extent to which the MBTA relied on standard versus custom-designed equipment.

As discussed in chapter 3, in order to provide travel times competitive with driving, it would be necessary for peak-period I-290 extension trains to run either non-stop or make a very limited number of stops between Framingham and Boston. Present and planned schedules for the Framingham / Worcester Line call for all peak-period express service east of Framingham to be provided by Worcester trains, and for peak-period trains originating or terminating at Framingham to stop at all stations between there and Boston. Therefore, all I-290 peak-period trains would need to be operated in addition to Framingham and Worcester trains rather than as extensions of Framingham trains.

To provide a level of service comparable to that on other MBTA commuter rail lines, an I-290 extension would need to have at least four trains scheduled to arrive in Boston between 6:30 and 9:30 A.M. Coordination with schedules of other trains would limit the maximum number of I-290 trips in this time span to five. With the estimated running times for express trains, it would be necessary to use four train sets to run either four or five inbound A.M. peak trips. The same four sets could be used to provide up to three reverse-commuting trips, but a fifth set would be needed to provide reverse-commuting schedules that did not require long gaps at times of heaviest demand. A start-up service with only three inbound A.M. peak and three outbound P.M. peak trips would require three train sets.

With locomotive-hauled trains, each set would require one locomotive. To allow interchangeability of train sets among assignments, present policy is to include at least six coaches in each train set used on the South Side. This would require 24 coaches for the four-set alternative or 30 for the five-set alternative. The cost of four locomotives and 24 double-deck coaches would be $68,040,000 excluding, engineering, administration and inspection during construction. The cost of five locomotives and 30 double-deck coaches would be $85,050,000. The cost of three locomotives and 18 cars for a start-up service would be $51,030,000.

Ridership diversions from present commuter rail service to I-290 trains would come mostly from Framingham or Worcester trains, with the balance from Fitchburg Line trains. Diversions from Framingham and Worcester trains would at most allow three train sets to be reduced from seven to six cars each. Re-assigning three coaches from present trains to I-290 trains would reduce the net rolling stock cost of the extension by $7,005,000. There would not be enough diversions from any individual Fitchburg Line train to justify reducing train lengths there.

The MBTA does not currently plan to acquire Diesel Multiple Unit cars for any of its commuter rail lines, so DMUs acquired for an I-290 extension would be used exclusively on that line. This would allow train lengths to be set according to demand rather than according to a minimum-length policy. Based on the demand estimates in chapter 4, the four-set alternative would require a total of 20 DMUs and the five-set

alternative would require a total of 22 in service each day. Three sets for startup service would require 15 DMUs. With spares to allow down-time for repairs, an additional two cars would be needed under each alternative. At $3,240,000 per car, this fleet would cost $71,280,000 with four sets or $77,760,000 with five. The cost of three sets would be $55,080,000. Cars no longer needed on Framingham or Worcester trains because of the extension could not be re-assigned to the extension itself, but could be re-assigned to other system lines. This would reduce the need for new equipment acquisition for those lines, and therefore could be treated as a credit against the cost of equipment for the I-290 extension.

Layover Facility

As discussed above and in chapter 3, service on an I-290 extension including four peak-direction and three reverse-commuting trips in each peak period would require a minimum of four trainsets. A fifth set would be needed to avoid long gaps in the reverse-commuting schedules, however. The most efficient deployment of equipment in terms of minimizing non-revenue mileage would have two sets based at the I-290 end of the line and two or three at the Boston end. The sets based at the outer end would make their first trips of the day in peak-direction, peak-period service and those based at the Boston end would start by making reverse-commuting trips.

Because of recent and planned expansion of commuter rail and Amtrak intercity service, however, the Boston yards would not have capacity for the two to three additional trainsets that would need to be stored there for efficient I-290 reverse-commuting service. Therefore the outer-end layover facility would have to have enough capacity for all train sets used on the extension. The minimum site size required for a layover facility for five trains sets would be about 50,000 square feet, or 1.1 acres. (For comparison, the same area would accommodate a surface parking lot with spaces for about 140 cars.) Based on recent construction costs for layover facilities on other MBTA commuter rail routes, the cost of a five-train layover facility would be at least $8,000,000, excluding land acquisition. Any savings in layover facility costs achieved by basing equipment for an I-290 extension at the East Fitchburg yard would be more than offset by necessary costs for upgrading tracks, crossing protection, and other fixed facilities between I-290 and Fitchburg.

The cost of $8,000,000 would provide for only a simple facility for overnight storage of equipment. With the addition of facilities for servicing, fueling, and repair of equipment, cost would be much higher. Present outlying layover facilities on the MBTA system are of the simpler variety, but lack of space in Boston may necessitate shifting of more maintenance functions to the outer terminals of new extensions. The impact of an I-290 extension on maintenance facility requirements in Boston including midday storage, and the associated costs, would need to be examined as part of the overall strategy for maintaining rolling stock for present service and for new extensions and service improvements. Such an analysis was beyond the scope of the present study.

Summary of Capital Costs

The capital costs discussed above for an I-290 extension are summarized in Table 5-1. (These include costs for parking facilities and rolling stock sufficient for estimated year 2020 ridership.)

Capital Costs Relative to New Transit Ridership

Capital cost per new transit rider is one measure commonly used in evaluating proposed transit projects. Estimates of total ridership and new transit ridership for an I-290 extension are discussed in chapter 4. Capital costs per new transit rider for the most likely alternatives are shown in Table 5-1 and discussed below. These costs are expressed in terms of new inbound riders, because most individuals using MBTA commuter rail make one inbound trip and one outbound trip each day that they use the system. The ridership figures used are projections for the year 2020, for consistency with other extension studies. Ratios for earlier years would be higher. In the 1994 PMT, the number of new transit trips shown for each project was the combined total of new riders in both directions. For comparison with the ratios in Table 5-1, the PMT costs per new rider must be doubled.

Of the alternatives shown in Table 5-1, the maximum service alternative (which would include four trains in each direction in each peak period and would also provide midday and evening service) would have the lowest cost per new transit rider. At projected year 2020 ridership levels, the cost using locomotives and coaches in push-pull configuration would be $130,080 per new rider. With DMUs the cost would drop to $124,860 because of the ability to match train lengths more closely with demand. A service that provided only as much reverse-commuting service as would occur as a by-product of peak-direction service would increase the cost per new rider to $137,900 with locomotives and coaches, or to $140,650 with DMUs.

Because of round trip running times, it would not be possible to operate an outbound A.M. peak trip at the time of greatest demand using rolling stock needed anyway for peak-direction service. This accounts for the higher capital cost shown for the maximum service alternative compared with the alternative with minimum reverse-commuting service. Among reverse commuters, however, the proportion of new transit users would be much higher than that among peak-direction riders, because existing transit alternatives do not serve the reverse-commuting market well. Therefore, the net result of acquiring the added rolling stock needed for full reverse-commuting service would be to reduce the capital cost per new transit rider for the extension service as a whole. A disadvantage of reverse-commuting service would be a substantial increase in operating cost relative to additional revenue, as discussed in chapter 6.

For comparison, with the figures above, the most recent estimate of capital cost per new transit rider in the year 2020 for the Worcester extension is $45,732. For the Newburyport extension, which opened in 1998, the projected figure was $93,055. Full implementation of the Worcester extension will require completion of intermediate

stations, currently under construction or final design, between Framingham and Worcester.

Table 5-1
Summary of Capital Costs for I-290 Extension

Item	Amount
Fixed Facilities	
Track, Signals, and Passing Sidings	$53,935,000
Grade Crossing Surface, Lights, Gates	2,775,000
Fencing	825,000
Bridges	1,000,000
Station Platforms and Shelters	4,000,000
Parking (assuming surface lots, including land)	12,685,000
Layover Facility	8,000,000
Contingencies	7,880,000
Engineering, Administration & Inspection	11,270,000
Subtotal	$103,370,000
Maximum Service - Rolling Stock	
Locomotives and Coaches	$85,050,000
Engineering, Administration & Inspection	5,100,000
Subtotal	$90,150,000
Total Capital Cost for Maximum Service	$192,520,000
Capital Cost per New Transit Rider (2020)	$130,080
Total Capital Cost with min. reverse commute	$172,375,000
Capital Cost per New Transit Rider (2020)	$137,900
Total Capital Cost for Maximum Service with DMUs	$184,795,000
Capital Cost per New Transit Rider (2020)	$124,860
Total Capital Cost with min. reverse commute with DMUs	$175,815,000
Capital Cost per New Transit Rider (2020)	$140,650

Notes: All costs are approximate; detailed engineering studies would be needed to refine costs. Costs for parking and rolling stock are based on year 2020 capacity requirements.

6. OPERATING COSTS AND REVENUES

Operating Costs

Operating costs for an I-290 extension would depend on the number of trips operated each day, the strategy used for coordinating I-290 service with other trains on shared track, the kind of rolling stock used, and the amount of non-revenue operation required to move trains between layover facilities and the ends of revenue trips. All MBTA commuter rail service is now provided by "push-pull" trains of locomotives and coaches, controlled in one direction from the locomotive and in the other from a cab in the end coach. Extension service alternatives for which costs have been calculated below include use of push-pull trains and use of Diesel Multiple-Unit (DMU) cars.

Schedules Assumed for Cost Analysis

An I-290 extension would be a branch off the Framingham / Worcester Line rather than an extension at the outer end. Half of the trains on the line in 2001 were Framingham short-turns. After the completion of additional intermediate stations, more of the trains will run through to Worcester. Remaining short-turns will be stop at all stations between Framingham and Boston. Extending them to I-290 would provide unattractive travel times to Boston from extension stations, so it was assumed that peak-period I-290 trains would run through to Boston as new express trips. I-290 train costs would be incurred on the extension itself and on the main line. I-290 trains would be of no direct benefit to users of stations they by-passed. Service at those stations could even become somewhat worse because of delays caused by increased congestion on the tracks.

For costing purposes, the minimum level of service examined was three inbound A.M. peak trips and three outbound P.M. peak trips, with no off-peak or off-direction service. Such a limited schedule would be run only as a short-term startup strategy. A service level significantly lower than now run on other lines would be unacceptable to area residents. As discussed in chapter 3, a more typical service level would include a minimum of four inbound trips in the A.M. peak and four outbound trips in the P.M. peak. In addition, the schedule would include eight off-peak trips each way spread throughout the day. This basic service level would include one outbound trip and one or two inbound trips at times suitable for some reverse commuters (but probably not for the majority). All together, this would result in a total of 12 weekday trains each way.

Given the schedule constraints of other I-290, Framingham, and Worcester trains, the maximum feasible level of reverse-commuting service would be four outbound A.M. peak and four inbound P.M. peak trips. In addition to the actual reverse-commuting trips, this would require operation of several trips in each direction to position trainsets at the beginning and end of the day. Especially in the morning these positioning trips would run at times with very low demand. Because of the limited capacity for overnight storage of equipment in Boston, it must be assumed for costing purposes that all rolling stock used on the extension would be based at a layover facility at or near the outer terminal. With all train sets based at the outer-end layover facility, there would

be 17 trains each way per weekday. During midday or evening hours, when demand potential would be much lower, costs could be reduced by providing some I-290 service with shuttle trains to Framingham.

Most MBTA commuter rail lines currently have Saturday and Sunday service as well as weekday service.[11] On lines that have Saturday service, the number of round trips ranges from 3 to 13, with 7 being the most common. On lines that have Sunday service, the number of round trips also ranges from 3 to 13, but 6 is the most common. For purposes of analysis, it assumed that if an I-290 extension had Saturday service it would have seven round trips, and if it had Sunday service it would have six round trips.

Cost Estimates

For reasons discussed elsewhere in this study, service on an I-290 extension would most likely be provided with trains of diesel locomotives and non-powered coaches. Based on the most recent available cost figures, the annual operating expense for weekday service with only peak-direction, peak-period service would be $2,630,000. A schedule with 12-round trips (including minimal reverse-commuting service) would cost $10,525,000 per year. With maximum reverse-commuting service, this would increase to $14,910,000. Saturday service with seven round trips would cost $1,305,000 per year. Sunday service with six round trips would cost $1,180,000 per year.

The costs above assume that all rolling stock would be based at a layover facility located at or near the outer terminal station. A facility at some distance from the station would require operation of more train-miles, and would therefore increase operating costs. If trains were based at the East Fitchburg yard, as suggested by the Marlborough Transportation Task force, every move between I-290 and the yard would generate 24 train-miles. Present MBTA practice in shifting equipment is to run at most two train sets coupled together. Therefore, with three sets based at East Fitchburg, at least two non-revenue train moves would be needed at the start of the service day and two at the end of the day. With five sets based at East Fitchburg, three non-revenue trips in each peak would be needed. The annual cost of moving three trainsets between East Fitchburg and I-290 for weekday service would be $1,135,000. The annual cost of moving five sets would be $1,700,000. As discussed in Chapter 5, the capital cost of a five-train layover facility would be about $2,300,000. Not even taking into account the cost that would be incurred in expanding the East Fitchburg yard, the expense of running trains between there and the end of an I-290 extension for just over two years would exceed the cost of building a layover facility near I-290.

The main advantage to operating Diesel Multiple Unit (DMU) trains rather than locomotive-hauled trains is the greater flexibility to vary train lengths by time of day to match demand when using DMUs. Operating costs for DMUs are uncertain because of

[11]As of Fall 2000, the only system segments served only on weekdays were the Fairmount Line, the Stoughton Line south of Canton Junction, and the portion of the Attleboro Line in Rhode Island. The Needham Line had service on Saturdays but not on Sundays.

limited recent experience in the United States with cars similar to those that would be needed for I-290 extension service. With the same unit costs assumed in a 1997 MBTA study[12], adjusted for inflation, the cost of operating the minimum weekday service schedule would be about $2,395,000 per year, or 9% less than the cost with locomotive-hauled trains. For the maximum weekday service schedule the cost with DMUs would be about $10,850,000 per year, or 27% less than the cost with locomotive-hauled trains. Lack of compatibility with other rolling stock used on the commuter rail system, and added maintenance costs for a small specialized fleet could reduce this advantage. Because of the differences between mechanical systems of DMUs and locomotive-hauled coaches, it is likely that a separate maintenance facility would need to be provided for DMUs. Costs related to such a facility are not addressed in this study.

Operating Revenues

Operating revenues were estimated for an I-290 extension with peak-direction, peak-period service only, for full peak-direction service with minimum reverse-commuting service, and for full peak-direction and reverse-commuting service. Revenue was also estimated for Saturday and Sunday service.

After deducting diversions of riders from other MBTA routes, full peak-direction and reverse-commuting service would generate the most new weekday revenue, at $2,630,000 per year with year 2000 demand. Full peak-direction service with only as much reverse-commuting service as would be provided as a by-product would reduce annual revenue to $2,325,000, or $305,000 less than with full service. The minimum schedule with only peak-direction, peak-period service would generate $1,230,000 per year in new revenue. Saturday service with typical frequency would attract about $185,000 per year in new revenue. Sunday service with typical frequency would attract about $110,000 per year in new revenue.

The demand forecasts show an overall ridership increase of about 26% between the years 2000 and 2020, but some of the new riders would choose other transit alternatives if there were no I-290 extension. Because of this and differences in expected gains by fare zone, the growth in revenue would be slightly lower, at about 24% if fares remained constant. It can be expected that fares will be raised between 2000 and 2020, but operating costs will also increase at an unknown rate.

Comparisons of Revenues and Operating Costs

Using calculation methods comparable to those used for all I-290 extension alternatives in this study, the revenue-to-operating cost ratio for the MBTA commuter rail system as a whole in the mid 1990s was around 42%. For weekday service alone, the ratio was about 45%. Taking into account subsequent changes in ridership, fares, and operating costs, the present ratios would be around 45% overall and 48% on weekdays.

[12] Massachusetts Bay Transportation Authority *New Bedford/Fall River Commuter Rail Project Expanded Alternatives Analysis prepared for the Massachusetts State Legislature*. March 1997.

Of the service alternatives examined for an I-290 extension, the only one with a revenue-to-cost ratio close to the systemwide average would be peak-direction, peak-period service only. At year 2000 ridership and cost levels, the ratio of added system revenue to added operating cost of this alternative would be about 47% with locomotive-hauled trains or 51% with DMUs. Such a limited schedule would be operated only as a short-term startup strategy. The favorable comparison of this revenue-to-cost ratio with that of the existing system is misleading, because the latter includes lightly patronized off-peak trains. The load factors on present peak-period trains would yield revenue-to-cost ratios much higher than 48% if they were evaluated separately from off-peak service.

At the opposite extreme, the alternative with maximum peak-direction and reverse-commuting service would have an incremental revenue-to-cost ratio of only 18% with locomotive-hauled trains, or 24% with DMUs. Maintaining full peak-direction service but maintaining only minimum reverse-commuting service would improve these ratios to 22% or 28%. These differences are attributable to the much lower average load factors on reverse-commuting service, and the need to add trips to reposition equipment for that service.

As noted in the preceding sub-section, ridership growth on an I-290 extension between 2000 and 2020 would increase annual revenue by about 24% if year 2000 fares remained in effect. It is difficult to predict the rates at which either fares or operating costs would increase during this time span. If they were to rise at equal rates, then revenue-to-cost ratios would also rise at the 24% rate indicated above. It is more probable however, that increased revenue from ridership gains would be viewed as justification for increasing fares at a slower rate than operating costs. In that case, the improvement in revenue-to-cost ratios would be lower. Even with a 24% improvement in revenue-to-cost ratio, the full-service alternative would still have a ratio of only about 22% with locomotive-hauled trains or 30% with DMUs in 2020.

Table 6-1
Cost and Revenue Comparisons for I-290 Extension (Year 2000 Levels)

Item	Limited Weekday Peak Service	Full Service, Limited Reverse Commute	Full Service, Maximum Reverse Commute	Saturday Service	Sunday Service
Annual Operating Cost (Locomotive-hauled)	$2,630,000	$10,525,000	$14,910,000	$1,305,000	$1,180,000
Annual Operating Cost (DMUs)	$2,395,000	$8,300,000	$10,850,000	$870,000	$645,000
Incremental Fare Revenue	$1,230,000	$2,325,000	$2,630,000	$185,000	$110,000
Incremental Revenue / Operating Cost (push-pull)	0.468	0.221	0.176	0.142	0.093
Incremental Revenue / Operating Cost (DMUs)	0.514	0.280	0.244	0.213	0.171
New Transit Riders per day (Year 2000 travel levels)	530	1,010	1,200	350	205

7. OPERATIONAL ISSUES

Impact of I-290 Extension on Other Commuter Rail Services

An I-290 extension would use the tracks of the Framingham / Worcester commuter rail line between Framingham Station and Boston. This line is mostly double-tracked, but a 1.7-mile single-track section adjoining the CSX Corporation's Beacon Park freight yard in Allston puts some constraint on schedules. On the double-track segments, signaling on both tracks allows trains to operate in either direction on either track. Crossovers about halfway between Framingham and South Station allow trains in either direction to change tracks.

An examination of present and planned schedules of Framingham and Worcester trains indicates that there is sufficient capacity to operate I-290 service on the line at the frequencies assumed for purposes of demand analysis and operating cost calculations. There would, however, be little flexibility in time slots assigned to I-290 trains. Slight delays of one Framingham, Worcester, or I-290 train could cause delays to several other trains because of scheduled meets at crossovers, passing sidings, or ends of double track. Further details on capacity constraints on the Framingham / Worcester line are discussed in appendix D.

Impacts on Intercity Passenger Service

Most Amtrak intercity passenger service in and out of South Station uses the Attleboro / Stoughton Line but a few intercity trains are also run on the Framingham / Worcester Line. In recent years this has usually included one round trip per day to Chicago via Albany and one round trip to New York and Washington, D.C. via Hartford. In some past years there were two New York round trips, but except in case of detours there have never been more than three since the startup of Amtrak in 1971.

The scheduled arrival and departure times of the Chicago and New York trains on the Framingham / Worcester Line have changed several times in the past. In October 2001 the train to Chicago was scheduled to leave Boston at 1:45 P.M., so the only potential schedule conflicts with I-290 trains would occur during midday. The train from Chicago was scheduled to arrive at Back Bay at 6:08 p.m. When it was running on time, it was scheduled to pass four outbound commuter trains between Framingham and there. The number could be greater or smaller if it was running late, as is not uncommon. I-290 service would increase the number of commuter trains in both directions that the inbound Chicago train would need to be scheduled around.

In Spring 2001 the outbound New York / Washington train via the Framingham / Worcester Line (Train 145) was scheduled to leave Boston at 7:20 A.M. Between South Station and Framingham it had to pass three inbound commuter trains. It did not have to overtake any outbound trains, but was due in Framingham about 15 minutes behind a local train. With I-290 service and expanded Worcester service, the number of inbound commuter trains that a New York train on the Spring 2001 schedule would

have to meet could increase to as many as five. The number of outbound trains still somewhere on the line between Boston and Framingham as the New York train left Boston could increase from two to three. (In September 2001 the departure time of Train 145 was changed to 9:50 A.M., after the end of the commuter service peak.)

In Spring and Fall 2001 the inbound train from New York via Framingham was due in Boston at 9:20 P.M. Commuter train service at that time of night is infrequent enough that the addition of I-290 service would not create major scheduling problems.

Impacts on Freight Service

Impacts on Framingham/Worcester Line

The Framingham / Worcester commuter rail line uses the east end of the CSX (formerly Conrail) Boston Line, which is the most heavily used rail freight route in New England. One of the announced goals of CSX in acquiring this line was to divert large amounts of freight from highways to intermodal rail service. If this goal is successful, it will result in increased numbers of freight trains on the Framingham / Worcester line.

As a base case, the number of freight trains is likely to be at least as great as it was in the final years of Conrail. The segment between Framingham and Beacon Park yard in Allston was then used by 4 to 6 through freights eastbound and 3 to 5 westbound on a typical weekday.[13] All of the westbound freights were scheduled to depart Beacon Park between 8:00 P.M. and 5:00 A.M., resulting in few conflicts with existing or potential future passenger train schedules. Two of the eastbound trains were scheduled to arrive at Beacon Park during the A.M. peak, however. Four other eastbound freight trains were due in Boston in mid-afternoon, but could actually arrive during P.M. peak hours. The freight trains at all times of day originated as far west as Chicago and Saint Louis, so they had high potential for late arrivals.

The scheduled times of freight trains using the tracks between Framingham and Beacon Park are determined largely by the schedules of other freight trains that they must connect with at points outside of Massachusetts. Available time slots are also limited by schedules of other through freight trains that operate on segments of the CSX Boston Line west of Framingham. At the end of Conrail operations, in addition to trains running to Beacon Park there were typically two through freight trains each way per day between Framingham and points west and another three each way between Worcester and points west. Much of the line west of Worcester is currently single-tracked, limiting the number of locations at which eastbound and westbound trains can pass or faster trains can run around slower trains.

[13]The term through freight refers to a long-distance freight train that stops only at a limited number of major rail yards to pick up or drop off cars. Local freight refers to a short-distance train that provides pick-up and delivery of freight cars at side tracks at many points along its route.

In recent years local freight service on the tracks between Framingham and Boston has been operated only on the segments between Framingham and Natick. Local freight trains are typically run either in the midday or in the evening to avoid conflicts with commuter train schedules. Several industrial sidings still exist between Beacon Park and Natick, but there has been no recent demand to serve them. This could change under CSX management, however.

Most segments of the Boston Line west of Framingham are used by at least one local freight train in each direction per day. These trains would not affect I-290 extension trains directly, but they do have an impact on schedules of some passenger and freight trains that continue to points east of Framingham. This, in turn, limits the time slots available for I-290 trains.

Impacts on Framingham Secondary Track

The route of the I-290 extension route between Framingham Station and I-290 has been used recently by up to three freight trains per day in each direction, all originating at the Framingham North Yard. One of these trains served most of the freight users on the line except for those within the Framingham Technology Park. As of July 1999, the northbound trip left the Framingham North Yard at about 10:00 A.M. and passed the assumed I-290 station site at about 1:00 p.m. In the intervening three hours it picked up and dropped off cars at several industrial sidings. The track configurations at each of these required that some freight cars remain on the main line during switching operations. The southbound return trip re-entered the extension service area in the early evening, but usually ran through to the North Framingham yard without doing additional switching work.

The operation of this train would conflict with operation of midday and evening commuter trains on an I-290 extension. Changes in the freight train schedule would affect freight delivery times and could make rail service less attractive for some of the present customers. One of the potential sites for a D'Angelo Drive station in Marlborough would require relocation of one of these freight customers.

Impacts at the Framingham Technology Park

A second train serves the Framingham Technology Park on the north side of the proposed California Avenue/Route 9 & 90 station site. Recently this train has been run at night when there would be little conflict with passenger service. As of July 1999 there were only two rail freight users in the Technology Park, although there were provisions for rail service at additional sites within the complex. The track layout is such that a train switching cars at any of the tracks in the Park can be completely clear of the main line most of the time.

The design for the California Avenue Station in the 1990 feasibility study called for a location in the northwest quadrant of the crossing of California Avenue and the rail line. The parking lot in this design would have replaced one of the two buildings in the

Technology Park to which freight cars are currently delivered. The platform location would have required removal of a side track that is not currently in service but that could otherwise be re-activated to serve future Park tenants.

There is insufficient vacant land in the vicinity of California Avenue to provide surface parking for a major park-and-ride facility without demolition of some existing buildings. Those that would have to be taken under the 1990 plan are somewhat older than others in the area and would probably involve lower acquisition and relocation costs than those in the other crossing quadrants.

A site in the northeast quadrant of the crossing would sever all rail freight access to the Technology Park. A site on the south side of the rail line would not interfere with freight service, but would require either substantial excavation or location of the parking lot at a much higher elevation than the platform. The only way to avoid or minimize building demolition would be to construct a multi-story parking garage in place of one of the existing nearby parking lots.

Other Impacts on Freight Service

Until recently, a third local freight train ran from the Framingham North yard to a lumber unloading facility at South Sudbury. This train used the route of the I-290 extension as far north as Framingham Centre, where it diverged onto the South Sudbury Industrial Track. Service was typically operated in midday hours, when there would be little difficulty in coordinating with passenger train schedules. The South Sudbury Industrial Track was out of service in Spring 2001, with its future status unclear.

The Framingham yards (which include both the North Yard and Nevins Yard parallel with the main line west of Framingham Station) have recently been the eastern terminal for two through freight trains per day in each direction. In addition, some through freights terminating at Beacon Park drop off cars at Framingham. Cars from arriving through freights are separated for delivery by local freight trains running in several directions from the Framingham yards. Conversely, cars from local freights are combined for pick-up by departing through freights. As discussed in chapter 3, to provide attractive running times on an I-290 extension, it would be essential to provide a track past the Framingham North Yard with a speed limit higher than the present yard speed. It would, however, be impossible to completely eliminate the need for freight trains entering or leaving the yard to run on or cross over some of the same tracks used by passenger trains.

Impacts at South Station

I-290 extension trains would have South Station as their Boston terminal. The ability of South Station to handle either additional trains or trains at times other than those currently scheduled must be taken into consideration. To provide travel times competitive with driving and levels of service comparable to that on other MBTA

commuter rail trains, the extension would add at least four inbound A.M. peak and four outbound P.M. peak trains to the number that would otherwise be using South Station.

As discussed in appendix D, with no changes from the Spring 2000 schedules other than planned increases in Worcester service, there would be open tracks at South Station at most of the times needed by I-290 extension trains. Planned service increases on existing lines and extensions including the Greenbush and Fall River / New Bedford lines are expected to fully utilize South Station capacity. Therefore, operation of I-290 trains could prove to be infeasible without further expansion or reconfiguration of this station.

Issues in Operation of Service with Diesel Multiple-Unit (DMU) Trains

In the past, when passenger service was operated on the Fitchburg Secondary Track, (the line that would be used for an I-290 extension) this line was not owned by the same railroad company as the route between Boston and Framingham. As a result, the operating strategies were not always the same as would have been used by a single operating entity such as the MBTA. Some trains from the Fitchburg Secondary were run through to Boston separately, some dropped off or picked up cars at Framingham that were coupled to main line trains between there and Boston, and others required passengers to change trains at Framingham.

Up to the time of the final discontinuance of passenger service on the Fitchburg Secondary in 1937, it was not common practice to attach self-propelled railcars to locomotive-hauled trains. Interchanging cars between trains at Framingham would have required some fairly complex and time-consuming switching moves. In later years after the advent of more modern rolling stock, some Boston-area branches were served by self-propelled cars that were attached to or detached from locomotive-hauled trains at main line junctions. This suggests that one strategy for serving an I-290 extension instead of running separate through trains would be to use self-propelled cars that would be attached to Worcester express trains between Framingham and Boston. As discussed below, there would be some problems in doing this with present-day equipment.

Currently all MBTA commuter rail trains are made up of locomotives and coaches in push-pull configuration. A train in this configuration is operated in one direction from the locomotive (pull mode) and in the other from an engineer's cab in the coach at the opposite end of the train (push mode). A diesel railcar attached to the end of such a train would now have to be capable of serving as the control car for the entire train when running in push mode, in addition to having controls for self-propelled operation when detached. There appears to be no technical reason why this could not be accomplished, although such an arrangement has seldom, if ever, been used in the United States.

A greater constraint, regardless of whether I-290 trains were run separately or combined with Worcester trains, is that self-propelled diesel railcars have not been

manufactured in North America for many years. (A new line of single-level and bi-level DMUs has recently been announced by Colorado Railcar, LLC, but at this writing no production models had been built.) Several models of DMU cars are made in European countries, but their designs make them incompatible for operation in trains with conventional coaches such as those used by the MBTA. Furthermore, most European DMUs would not meet the latest U.S. standards for crash-worthiness promulgated by the Federal Railroad Administration (FRA). This limits their use to lines that are either used by no conventional passenger trains or freight trains, or on which operation of DMUs can be restricted to different times of day from that of other trains. This would clearly not be the case on the Framingham / Worcester Line. Even if the DMUs were run only between I-290 and a separate transfer platform at Framingham, they would still need to share the extension tracks with freight trains, and operation of the Framingham North freight yard could not be restricted to hours with no passenger service.

For the reasons cited above, if service on an I-290 extension were provided with DMUs it might be necessary to use custom-designed cars. It might also be necessary to re-equip Worcester trains entirely with these cars for compatibility. At present, the train sets used on the Worcester line have a mix of single-level and double-deck coaches. Most of the diesel railcars ever built have been single-level models. It is unclear whether a double-deck DMU with capacity equal to that of an MBTA double-deck coach could be obtained. If not, re-equipping Worcester trains with DMUs would require longer sets even without the added cars from the I-290 extension. This would limit flexibility in platform assignment for these trains at South Station, where tracks are not all the same length. It would also result in higher capital and maintenance costs than those for present trains with equal capacity.

At present, none of the trainsets that run on the Framingham / Worcester Line are used exclusively on that route. Rolling stock is rotated from route to route for several reasons, including efficiency of utilization, equalization of miles per car between routine inspections, and allowance of time for maintenance at the main repair facilities in Boston. As of May 2000, three of the four trainsets that originated at the Worcester layover facility each morning returned there the same night. The fourth set was rotated to Southampton Street for maintenance and replaced by a set that started the day at East Junction on the Attleboro / Stoughton Line. Conversion of the Worcester trains to DMU operation would require that equipment for these trains be assigned exclusively to that line unless other South Side lines also used DMUs.

One of the arguments in favor of DMU use is the supposed ability to couple and uncouple trainsets with no delays. Some European systems do make use of DMUs that are capable of joining or separating while the trains are in motion. The New Bedford / Fall River commuter rail study concluded that federal regulations would require that standing brake tests be performed after coupling DMUs into trains. It was estimated that this would force the train to be stopped for at least 7 minutes. In situations where the coupling operation would be done at a location other than that where the branches joined, the two trains would have to use the same track for some

distance. This would cause additional delay, as signals or operating rules would require that the second train wait for several minutes before following the first over the shared track segment. With the present track layout at Framingham Station, it would not be possible for coupling and uncoupling of I-290 and Worcester trains to be done at the platforms there. The nearest possible location for this would be at the crossovers at CP-21, on the main line 0.1 miles east of the station.

At present, the area above the platforms at South Station is partly covered by the bus terminal and parking garage. MBTA commuter rail trains are usually run with the locomotives at the outer ends. This allows them to be stopped either with the locomotives underneath ventilator shafts in the building above, or before they reach it, to minimize exhaust fumes in the platform areas. DMU trains would emit exhaust from every car, requiring ventilation over the full length of each train. A planned future high-rise office building will cover much or all of the remaining open area between the bus terminal and the inner platform ends. The ventilation system beneath this building would have to be more complex and costly for DMU operation than for push-pull train operation.

Issues in Operation of Combined Trains with Push-Pull Equipment

As an alternative to DMUs, it would be possible to operate combined I-290 and Worcester trains by coupling two train sets of push-pull cars, including engines, together at Framingham. For many years, MBTA commuter rail equipment assignments have called for some revenue-service trains to be run with two push-pull sets coupled together. This has been done to reduce the cost of shifting equipment from one end of a line to the other rather than to increase capacity, but it does demonstrate the technical feasibility of such an operation.

Present practice is for all commuter rail trains to run with the locomotives on the outer end, to minimize noise near the Boston terminal waiting rooms. When double sets are run, this puts the locomotive on the second set in the middle of the train, preventing passengers or train crews from walking between the two sections. On such trains, only one half is opened for passengers. To maximize efficiency of combined I-290 and Worcester service, one of the train sets in each pair would have to be run with the locomotive on the inner end. When coupled together, the trains would have the locomotives at the extreme ends and the cab control cars in the middle. Passengers and train crew would then have access to all cars. Although MBTA commuter rail trains do not ordinarily run with locomotives on both ends, they occasionally do so when running in special service outside of their usual territory, again proving the technical feasibility of such operation. The delay incurred in coupling trains and performing brake tests would be about the same for push-pull equipment as for DMUs, or a minimum of about 7 minutes.

Impacts on Air Quality

Air quality impacts of transit projects are typically calculated on the basis of expected changes in vehicle miles of travel (VMT) resulting from the project. For the Boston region, the automobile-generated pollutants of greatest concern are carbon monoxide (CO), nitrous oxides (NOx), and volatile organic compounds (VOC). Based on the alternate travel modes of the expected users of an I-290 extension, a schedule including maximum reverse-commuting service would produce the largest reduction in VMT of all the options examined. For this alternative, the net VMT reduction would be about 42,895 per weekday at year 2000 travel levels. (All calculations of air quality impacts below are based on the year 2000 ridership estimates, because emissions characteristics of automobiles, diesel locomotives, and Diesel Multiple Unit (DMU) trains are all likely to improve significantly, but by unpredictable amounts, between 2000 and 2020.)

With full peak-direction service but minimum reverse-commuting service there would be a net reduction of 36,555 VMT per weekday. Service limited to A.M. peak inbound and P.M. peak outbound trains would result in the smallest VMT reduction of any of the alternatives examined. For this alternative, the net VMT reduction would be about 20,105 per weekday. (All of the figures above exclude reductions resulting from new transit riders being attracted to existing services as a result of capacity freed up by diversions to the I-290 extension.)

The improvements in air quality associated with VMT reductions for these I-290 extension alternatives would be as shown in Table 8-1. At the same time, however, the diesel locomotives or railcars used on trains would add emissions to the air. In addition to CO, NOx, and VOC, particulate matter (PM) is of concern for diesel vehicles. For the same three alternatives, locomotive emission increases would be as shown in Table 8-2. Also shown in the table are emission increases for DMUs for the maximum service alternative. The net impact of the reduction in auto emissions and increase in locomotive or DMU emissions would be as shown in Table 8-3. Emissions characteristics of DMUs would depend on the particular model of car used. The figures in Tables 8-2 and 8-3 are based on cars with fuel consumption characteristics similar to those of rebuilt Budd RDCs with new engines.[14]

All of the alternatives analyzed would result in overall reductions in CO and VOC levels. There would be increases in NOx and particulate matter levels in all alternatives. The greatest reductions in VMT and in CO and VOC levels would occur with the maximum service alternatives, but these would also result in the largest increases in NOx and PM levels.

[14]Although new Budd RDCs were last built in 1962, overhauled RDCs with new engines have been used in recent commuter rail startups in Syracuse, New York and Dallas, Texas.

Table 8-1
I-290 Extension with Year 2000 Ridership
Reduction in Average Weekday Auto Emissions

	Limited Weekday Peak Service	Full Service with Limited Reverse Commute	Full Service with Maximum Reverse Commute
VMT Reduction	20,105	36,555	42,895
CO Reduction	201.7 kg	366.7 kg	430.4 kg
NOx Reduction	34.1 kg	62.0 kg	72.7 kg
VOC Reduction	18.8. kg	34.2 kg	40.2 kg

Table 8-2
I-290 Extension with Year 2000 Ridership
Increase in Average Weekday Train Emissions

	Limited Weekday Peak Service	Full Service with Limited Reverse Commute	Full Service with Maximum Reverse Commute	DMU Full Service with Maximum Reverse Commute
CO Increase	15.0 kg	42.9 kg	58.4 kg	33.3 kg
NOx Increase	138.5 kg	456.0 kg	632.3 kg	355.5 kg
VOC Increase	5.5 kg	15.2 kg	20.6 kg	11.8 kg
PM Increase	1.6 kg	5.9 kg	8.3 kg	4.6 kg

Table 8-3
I-290 Extension with Year 2000 Ridership
Net Change in Average Weekday Emissions

	Limited Weekday Peak Service	Full Service with Limited Reverse Commute	Full Service with Maximum Reverse Commute	DMU Full Service with Maximum Reverse Commute
CO Change	-186.7 kg	-323.8 kg	-372.0 kg	-397.1 kg
NOx Change	+104.4 kg	+394.0 kg	+559.6 kg	+282.8 kg
VOC Change	-13.3 kg	-19.0 kg	-19.6 kg	-28.4 kg
PM Change	+1.6 kg	+5.9 kg	+8.3 kg	+4.6 kg

Impacts on Water Resources

An I-290 commuter rail extension would operate entirely over a line that is now used for local freight service. Passenger service would, however, result in a large increase in the number of trains using the line. For the first mile north of Framingham Station the track runs along the east shore of Farm Pond. This is also the portion of the line where the Framingham North freight yard is located, making it the most active section of the route. For a distance of 0.6 miles in the segment between Framingham Centre and

California Avenue, the extension route runs along the shore of MWRA Framingham Reservoir No. 3, including a 55-foot trestle across an arm of the reservoir. In Southborough the rail line crosses the MWRA Sudbury Reservoir on a causeway and a 20-foot stone arch bridge. The rail line also passes near the end of the inlet channel to this reservoir at the border of Marlborough and Northborough. In Northborough the rail line crosses the headwaters of the Assabet River on a 12-foot stone arch bridge and the inlet to Brush Pond on a 14-foot stone arch.

In the past, Farm Pond, Reservoir No. 3, and the Sudbury Reservoir were all used as part of the public water supply for Metropolitan Boston. Farm Pond and Reservoir No. 3 have not been used as such for many years because of poor water quality. The Sudbury Reservoir is used only in emergencies, and is expected to be taken off-line completely following the completion of a new aqueduct to Boston. Nevertheless, an I-290 rail extension would presumably require appropriate drainage system upgrading to prevent runoff from the tracks from worsening pollution of any of the major bodies of water they cross.

The rail line does not directly abut any other ponds or lakes, but it crosses the edges of Crane Swamp and Little Crane Swamp and the watershed of Bartlett Pond in Northborough. At the I-290/Northborough station site proposed by the Marlborough Transportation Task Force, the rail line is directly beside the MWRA Wachusett Aqueduct, which consists of a brick tunnel covered in an earth embankment. This aqueduct is not used regularly, but provides an emergency supply line from the Wachusett Reservoir. It would need to be protected from runoff seepage from both the rail line itself and from a station parking facility.

Small stone culverts carry brooks under the right-of-way in several locations. Some of these may require some upgrading to carry passenger trains. Drainage improvements would be made as necessary at these as well as at other locations where the rail line runs close to wetlands.

Impacts on Community and Cultural Resources

This impact category covers changes that would occur to historic buildings, sites, or districts; to archeological sites; to parks or open spaces; and to buildings or resources that are important to the expression of cultural values, such as schools, churches, and monuments.

Except in the segment between Framingham Station and Framingham Centre, most of the land adjoining the I-290 extension route is either sparsely developed or is used for industrial purposes. There do not appear to be any cultural or community resources close enough to the line in Marlborough to be negatively impacted by it. In Southborough, the rail line runs along the border of Fay Memorial Field (a public recreation area) and passes within 200 feet of the Fayville Village Hall.

In Northborough, the extension would pass directly through the town center. In that vicinity there is a church about 200 feet east of the track, but separated from the railroad by a street. (The Northborough town hall is about 1,000 feet from the east side of the track.) Near Framingham Centre a church on a hill about 500 feet from the tracks would overlook the parking lot of the Salem End Road Station site proposed in the 1990 feasibility study cited in chapter 1.

Traffic Impacts on Major Arterial Routes

The reductions in auto travel resulting from an I-290 extension would be distributed over several different routes. There is no readily available information as to the current division of traffic from the extension service area among these routes. Based on relative travel times, it is likely that the Mass. Turnpike east of Interchange 13 in Framingham carries the largest share of I-290 extension corridor traffic of any individual route alternative. If all auto trip diversions to the extension came from the Turnpike, the maximum service alternative would remove about 685 cars each way per day at year 2000 travel levels. The highest concentration of these would occur between 7:00 and 8:00 A.M., when about 215 eastbound cars would be removed. This would be about 3% of the capacity of this road over the same time span. At present, peak-period traffic on the Turnpike is usually free-flowing except for some backups of exiting vehicles approaching interchanges. The volume of traffic removed as a result of an I-290 rail extension would not have an appreciable impact on traffic flow on the Turnpike. (Some congestion at the Boston end is related to construction work on the Central Artery project, which will be completed before I-290 rail service could be implemented.)

Traffic Impacts of Station Access

Under the configuration assumed for purposes of analysis, boardings on an I-290 extension would be divided among four stations. The Framingham Centre station would be the most heavily used of these. Under the maximum service alternative, this station would serve an estimated 695 riders per day at year 2000 travel levels. The D'Angelo Drive / Marlborough station would be second, with 515 boardings. The Route 9 & 90 station in Framingham would be a close third, with 500 boardings. The I-290 terminal in Northborough would be last, with 325 boardings.

Including vehicles arriving either to park or to drop off passengers, the most heavily used train would generate about 140 auto-access trips to the Framingham Centre station, about 130 to the Route 9 & 90 station, about 110 to the D'Angelo Drive station, and about 80 to the I-290 Station. In the final minutes prior to this train departure, average rates of auto arrivals would range from about 10 per minute at I-290 to about 17 per minute at Framingham Centre. These arrival rates would be lower than the present peak arrival rates at Framingham Station, the station now most frequently used by residents of the I-290 extension service area. Access trips would not all be from one direction at any of the stations. Framingham Centre, which would have the highest auto arrival rate of any of the extension stations, would also have the greatest number of possible approach routes.

Grade Crossings

The rail line between Framingham Station and I-290 in Northborough has 12 grade crossings of public roads. As detailed in chapter 5, all of these crossings are currently protected by automatic flashing lights, but only three also have gates. In conformance with recent practice on MBTA commuter rail extensions, it is assumed that for passenger service to I-290 all of the public crossings and the more heavily used private crossings would have gates installed.

Traffic counts have not been made at all of the crossings on the I-290 extension route, but only three are on major highways. These are the crossings of Route 9 at Framingham Centre, Route 30 in downtown Southborough, and Route 20 in downtown Northborough. At the crossing location Route 9 has two travel lanes in each direction and a median barrier on either side of the rail line. Where Routes 30 and 20 are crossed, both are undivided, with a single travel lane in each direction.

In addition to being an important arterial traffic route, the portion of Route 9 in Framingham Centre serves a densely developed commercial district. The most recent published 24-hour traffic count there shows that in 1991 an average of over 48,000 vehicles per day (24,000 in each direction) passed over the railroad crossing. This was a growth of over 20% compared with counts from 20 years earlier. Peak-period counts taken in March 1999 show 3,883 vehicle crossings in the maximum A.M. hour and 3,796 in the maximum P.M. hour. The heaviest hourly single direction volume was 2,446 eastbound in the A.M. or an average of 20.3 per minute in each of the two travel lanes. Delays to traffic when trains were crossing would be similar to those at signalized intersections with major crossroads. Trains would occupy the crossing for at most four times per hour. In contrast, signalized intersections are typically clear for no more than about two minutes at a time for the main route.

On Route 30 in Southborough, the nearest traffic count location to the railroad crossing is about 1.7 miles to the east. Counts taken there in 1997 showed an average of 21,000 vehicles per day. This was a slight increase from 1990 traffic levels, following declines in 1991 and 1994 counts. The 1997 traffic level on this section of Route 30 was more than six times that in 1971, but the trend in the 1990s suggests that road capacity will limit further growth. Because of locations of intermediate connecting roads and traffic generators, not all vehicles at the 1997 count location would have passed over the railroad crossing, but most vehicles going over the crossing would also have gone through the count location.

Counts on Route 20 in downtown Northborough showed that in 1992 an average of 14,100 vehicles per day passed over the grade crossing. Earlier counts for this location are not available.

The only other published traffic counts for public roads with grade crossings on the I-290 extension route are for Colburn Street and Pierce Street in Northborough. Colburn Street is part of the posted access route from downtown Northborough to

I-290, but a 1997 count showed an average of only 2,200 vehicles per day in the vicinity of the grade crossing. This was, however, an increase of over 20% from 1991. This crossing is at the I-290 station site proposed by the Marlborough Transportation Task Force. The number of I-290 extension passenger trains having to pass over this crossing would depend on the final siting of the station platforms and the location of layover facilities for the extension. Likewise, new traffic over the crossing going to or from the station parking facility would depend on which side of the track the facility was on and the direction from which the highest traffic volume approached.

At Pierce Street, the only available count is from 1992. It shows 1,400 vehicles per day in the vicinity of the grade crossing. Pierce Street can be used in accessing I-290 from Northborough Center, but it is not part of the posted access route.

The seven public grade crossings for which traffic counts are not available are on roads that are designed mainly to serve local traffic, but some motorists may use them as shortcuts between through routes. Central Street in Southborough provides a convenient link between Route 30 and Route 9. Salem End Road and Maple Street in Framingham are both primary access routes to parking lots for Framingham State College students, with respective capacities of about 250 and 300 cars. Both lots directly abut the east side of the rail line, so only cars approaching the lots from the west or departing west would pass over the crossings. (The 1990 feasibility study assumed that the Salem End Road lot would be replaced by a multi-level joint-use garage serving the college and a new station there.) Four grade crossings in Northborough are on primarily residential streets (School, Summer, and Brigham streets, and Collins Road) that can also be used for through traffic access to Route 20 or Route 135.

The private grade crossing at California Avenue in Framingham is on one of the only two access roads into the Framingham Technology Park. Traffic counts taken in 1994 show maximum traffic volume on California Avenue toward the park occurring between 7:45 and 8:45 A.M. with a total of 700 vehicles entering. About 95 vehicles exited the Park via California Avenue in the same hour. Maximum activity away from the Park occurred between 4:45 and 5:45 p.m., when a total of 633 vehicles exited. About 175 vehicles entered the Park via California Avenue in the same hour.

At the time of the counts, California Avenue was accessible only from the westbound side of Route 9. In order to reduce traffic in and out of the Technology Park on the Route 30 side, the Mass. Highway Department was reconstructing the California Avenue intersection in 1999 to provide access from the eastbound side of Route 9 as well. It is projected that by the year 2004, A.M. peak-hour volumes on California Avenue will increase to 1,855 vehicles entering and 297 exiting the Park. P.M. peak-hour volumes will increase to 1,454 exiting and 489 entering vehicles.

An I-290 commuter rail extension with levels of service consistent with that on other MBTA commuter rail lines would have two inbound trains and one or two outbound trains (depending on the level of reverse-commuting service) using the California Avenue crossing during the morning maximum highway-traffic hour. Similarly, in the

P.M. peak-traffic hour there would be two outbound and one or two inbound trains using the crossing. Trains passing over the crossing would be either accelerating from the California Avenue station or decelerating for it. Including advance time for signal activation, each train going over the crossing would block traffic for approximately one minute.

The greatest conflicts would be with A.M. peak entering traffic, which would average 31 vehicles per minute. The crossing site is about 700 feet north of Route 9. This would be sufficient to hold 31 closely-spaced automobiles in a single line without causing backups out onto Route 9, but traffic volume at the time of a specific train crossing could be higher or lower than the one-minute average. The planned re-design of California Avenue will include only a single lane at the entry on Route 9, but may allow for widening to two lanes at some point before the crossing.

In the P.M. peak, backups of exiting traffic at the railroad crossing would extend back into circulation roads within the Technology Park. The release of traffic queues following the passing of trains could cause some brief congestion entering Route 9. Of greater concern would be possible backups of exiting traffic from Route 9 back across the railroad crossing as trains were approaching.

The private grade crossing at D'Angelo Drive in Marlborough serves an expanding industrial area south of the crossing but it is much less heavily used than California Avenue. Counts taken at the entry to D'Angelo Drive in 1998 show maximum traffic volumes of 216 southbound and 26 northbound vehicles between 8:00 and 9:00 A.M. Afternoon volumes peaked at 209 northbound and 32 southbound between 4:45 and 5:45 p.m. Under the most likely schedule for commuter rail service, there would be one inbound and one or two outbound trains over the D'Angelo Drive crossing in the maximum morning traffic hour. There would be two outbound and one or two inbound trains in the maximum afternoon traffic hour. Any traffic backups would affect only industrial roads, and would not be substantial.

Impacts on Abutters

Negative impacts for residents of houses abutting an I-290 extension would consist of noise and vibration from trains as they pass and the sounding of train horns at the grade crossings. These impacts would be greatest on houses located within 200 feet of the right-of-way.

Most of the land in the immediate vicinity of the rail line between Framingham Centre and I-290 is sparsely developed, but there are clusters of houses at several points along the line. The segment between Framingham Centre and Framingham Station runs through a much more densely developed area, but on about half of this segment the track that would be used by passenger trains is separated from dwellings by Farm Pond to the west and by the Framingham North rail freight yard to the east.

For this study, approximate counts of the number of houses within 200 feet of the right-of-way were obtained from aerial photographs, topographic maps, and field observations. These showed a total of about 190 such houses over the entire length of the route from Framingham Station to I-290 in Northborough. Of these, 80 were in Framingham, 65 in Southborough (including both segments of the line in that town) and 45 in Northborough. Developed land along the two segments of the line in Marlborough is occupied almost entirely by industrial, commercial, or office buildings. Only two houses were found within 200 feet of the railroad in Marlborough.

It should be noted that many of the remaining undeveloped parcels in all four communities traversed by the extension route adjoin the railroad. In the past, such land was considered less desirable for development than property further from the tracks. Future demand for new housing can, however, be expected to result in increases in the number of homes located near the rail line compared with the totals reported above.

9. SUMMARY AND CONCLUSIONS

A commuter rail extension on the Fitchburg Secondary Track from Framingham Station to Route I-290 in Northborough could be feasible from an operations standpoint. Capacity constraints between Framingham and Boston would, however, require very close schedule adherence to prevent delays on one trip from spreading to many others. Flexibility in setting arrival and departure times of I-290 trains would also be very limited.

An I-290 extension would produce moderate benefits for the costs involved. At year 2000 travel levels, stations on the extension would serve about 2,125 inbound boardings on a typical weekday if the maximum feasible levels of peak-direction and reverse-commuting service were provided. Of these riders, about 1,165 (55%) would be new MBTA system users, including about 210 making return halves of reverse-commuting trips to Boston or intermediate stations. The remainder would be diverted from other MBTA commuter rail, rapid transit, or bus service. Another 35 new transit users would be attracted to Framingham Station as the result of increased reverse-commuting schedules there. Total boardings on the extension along with new Framingham Station riders would increase to about 2,730 by the year 2020.

If I-290 reverse-commuting service were limited only to that which would be provided as a by-product of peak-direction service (as is typical on existing MBTA commuter rail lines) inbound boardings would be reduced to about 1,970 at year 2000 levels, or 2,500 in 2020. The decreases in ridership compared with maximum service would all be in new transit users, since present transit services carry almost no reverse-commuters to the extension service area.

A minimum service level consisting of only three inbound A.M. peak trains and three outbound peak trains with no off-peak or off-direction service would carry about 1,055 inbound riders a day at year 2000 levels or about 1,345 in 2020. Such a low service level would be provided only as a temporary start-up strategy, however.

In order to offer attractive travel times to Boston, I-290 extension trains would have to run either non-stop or with no more than one or two intermediate stops between Framingham Station and Back Bay Station. Therefore, there would be little or no perceived service improvement to attract new riders to stations on the main line east of Framingham. Some new riders might be attracted to those stations as a result of parking capacity freed-up by riders diverted to the extension, but such secondary effects would be too small to calculate. At Framingham Station itself, scheduling constraints would require peak-period peak-direction I-290 trains to depart so close to times of Worcester express trains that there would be little perceived improvement in frequency.

The maximum highway traffic reduction resulting from an I-290 extension would occur on the Mass. Turnpike east of Interchange 13 in Framingham. The reduction there in

the number of peak-direction vehicles during commuting hours would be about 3% of the total capacity of the road.

Estimated commuter rail running times to South Station from the outer three stations on an I-290 extension would be three to six minutes longer than present typical A.M. peak driving times to the South Station area from the vicinities of these stations if the trains ran non-stop from Framingham Station to Back Bay. Train time from Framingham Centre to South Station would be about four minutes faster than driving time. Very few riders would have their actual trip starting points close to the stations they would use, however, and in most cases the most direct driving routes do not run past the stations. Most commuter rail passengers arrive at their boarding stations a few minutes prior to train departure. For these reasons, comparisons of train times and driving times between stations understate the relative time advantages of driving. Train times to Boston from all stations would be significantly faster than present scheduled bus times, but present bus service from the extension corridor serves very few riders.

Of the I-290 extension service alternatives analyzed, a limited schedule providing only peak-period peak-direction service would have the highest ratio of incremental revenue to incremental operating cost. Revenue for such an alternative at year 2000 travel levels would cover about 47% of incremental operating cost if provided with conventional push-pull equipment. Substitution of Diesel Multiple-Unit (DMU) trains would raise the ratio to about 51%. For comparison, the revenue-to-cost ratio for weekday service on the MBTA commuter rail system as a whole with Fall 2000 fares and unit costs was about 48%. This included extensive off-peak service with a lower ratio, however. An I-290 extension with all-day peak-direction service and limited reverse-commuting service would have a revenue-to-cost ratio of about 22% with push-pull equipment or 28% with DMUs. With maximum reverse-commuting service included, these ratios would drop to about 18% and 24%.

Based on recent construction and equipment acquisition costs, the capital costs for an extension to I-290 with maximum peak-direction service but minimal reverse-commuting service would total $172.4 million. This figure includes necessary right-of-way improvements, station platforms, parking sufficient for year 2020 demand, and additional push-pull equipment, plus engineering and contingencies. Using DMUs instead of push-pull trains would increase the total capital cost under this service alternative, to $175.8 million, because the higher per-car cost of DMUs would offset the slightly lower total number of cars needed. Additional rolling stock needed to operate maximum reverse-commuting service in addition to maximum peak-direction service would raise the capital cost requirement with push-pull equipment to $192.5 million. With DMUs, the capital cost would increase only to $184. 8 million, because the additional rolling stock purchase could be matched more closely to the additional capacity needed.

Capital costs per new inbound transit rider at estimated year 2020 ridership levels for the various I-290 extension alternatives are shown in Table 9-1. The most cost-effective alternatives in this measure would be those with maximum peak-direction and reverse-

commuting service. Those alternatives would have capital costs per new transit rider of $130,080 using push-pull equipment or $124,860 using DMUs. For comparison, the capital cost per new transit rider for the Newburyport extension, which opened in 1998, was estimated at $93,055. (The most recent available estimated cost per new year 2020 transit rider for the Worcester extension is $45,732.)

Any of the I-290 extension alternatives analyzed would improve air quality slightly in terms of carbon monoxide and volatile organic compound (CO and VOC) emissions, but would increase emissions of nitrous oxide and particulate matter (NOx and PM).

The findings in this chapter are summarized in Table 9-1.

Table 9-1
Summary of Performance Measures for
Extension from Framingham to I-290 / Northborough

Item	Limited Weekday Peak Service	Full Service with Limited Reverse Commute	Full Service with Maximum Reverse Commute	DMU Full Service with Maximum Reverse Commute
Weekday Inbound riders (2000 travel levels)	1,055	1,970	2,160	2,160
New Inbound Transit Riders (2000 travel levels)	530	1,010	1,200	1,200
Weekday Inbound riders (Year 2020)	1,345	2,500	2,730	2,730
New Transit Riders (Year 2020)	655	1,250	1,480	1,480
Annual Operating Cost	$2,630,000	$10,525,000	$14,910,000	$10,850,000
Incremental Fare Revenue (2000 travel levels)	$1,230,000	$2,325,000	$2,630,000	$2,630,000
Incremental Revenue / Operating Cost	0.468	0.221	.176	0.244
Capital Cost	$131,880,000	$172,375,000	$192,520,000	$184,795,000
Capital Cost / New Rider (year 2020)	$201,345	$137,900	$130,080	$124,860
Weekday VOC Reduction (2000 travel levels)	13.3 kg	19.0 kg	19.6 kg	28.4 kg
Capital Cost / Kg of Weekday VOC Reduction	$9,915,789	$9,072,368	$9,822,449	$6,506,866

APPENDIX A - FURTHER DETAILS ON EXISTING PUBLIC TRANSPORTATION SERVICE IN STUDY AREA

Descriptions of Existing Bus Routes

Chapter 2 of this report provides general descriptions of the bus routes serving the I-290 extension corridor directly or indirectly as of Spring 2001. The first section of this appendix describes the private-carrier bus routes in greater detail. The second section contains transit ridership information for the I-290 extension corridor. All of the routes described below except for the Marlborough/Route 495 Business Area route are funded through the MBTA Interdistrict Transportation Service (IDTS) program.

Post Road Line

The outer terminal of this line is at the intersection of Routes 135 and 20 in the center of Northborough. Buses run on Route 20 through Northborough, Marlborough, Sudbury, Wayland, and Weston, except for diversions through downtown Marlborough on Main Street and through downtown Weston on Boston Post Road. They then follow Route 128 and the Mass. Turnpike into Boston.

This route currently has one inbound trip in the A.M. peak and one outbound trip in the P.M. peak. The present operator of the route (Cavalier Coach Corporation) is based in Boston. The pull-out of the bus from Boston to Northborough before the inbound morning trip and the pull-back from Northborough to Boston after the evening outbound trip have been shown in published schedules since 1998 as reverse-commuting service. The arrival and departure times are not convenient for many work schedules, however. There is no off-peak service on this route. A second inbound A.M. peak and outbound P.M. peak trips were discontinued by a prior operator in 1984 because of low ridership.

Schedules show locations of one stop in Northborough, two each in Marlborough and Sudbury, and one each in Wayland and Weston, but a note in the schedule states that buses may stop at any safe location along the route. Of the cities and towns on the route, only Northborough and Marlborough would be served directly by an I-290 commuter rail extension. The present bus stops in Northborough and Marlborough serve the traditional downtown business districts. In contrast, the rail extension, as envisioned by the Marlborough Transportation Task Force, would serve large park-and-ride facilities near major highway interchanges and new office and industrial parks.

At the inner end of the Post Road Line, buses leave the Mass. Turnpike at the Copley exit and make stops at Copley Square, Park Square, Essex Street, and Government Center. Scheduled running times to Copley are 60 minutes from downtown Marlborough and 70 minutes from the end of the line in Northborough. Scheduled times are three minutes longer to Park Square, 10 minutes longer to South Station, and 15 minutes longer to Government Center. Based on the most recent available information on traffic conditions, the scheduled times would be slightly longer than the

average actual times for the routes used. Most automobile trips to Boston from Northborough or Marlborough use much faster routes, however, as discussed in chapter 2.

Marlborough/Route 495 Business Area Route (discontinued)

From September 1998 to April 2001, Cavalier Coach operated a reverse-commuting route from Boston to industrial and office parks near Route I-495 in Marlborough. Buses on this route stopped at South Station, Park Square, and Copley Square in Boston, then proceeded via the Mass. Turnpike and I-495 to the Route 20 exit in Marlborough. They then followed Route 20, Williams Street, Forest Street, Puritan Way, Crane Meadow Road, and Simarano Drive to Ames Street.

Service consisted of one outbound trip leaving South Station at 7:10 A.M. with a return trip leaving Ames Street at 5:30 p.m. Scheduled running times from South Station to stops in Marlborough ranged from 60 to 75 minutes. Times from Copley were 15 minutes shorter. After completing the morning run, the bus picked up passengers at four hotels near Routes 20 and I-495 and returned non-stop to Copley Square via I-495 and the Mass. Turnpike. Similarly, in the evening the bus ran from Copley to the Marlborough hotels before picking up passengers at the I-495 business area. Service was discontinued in April 2001 because of low ridership and expiration of funding.

Gulbankian Bus Lines Hudson-Boston Route

This route begins in downtown Hudson at the intersection of state Routes 62 and 85 and follows a combination of Route 85 and parallel local roads through Marlborough and Southborough to Route 9. It then follows Route 9 to Mass. Turnpike Exit 12 in Framingham, and the Turnpike to downtown Boston. Published schedules currently show one stop each in Hudson and Marlborough, two in Southborough, and one in Framingham, but a note in the schedule states that buses may stop at any safe location along the route.

Of the cities and towns on this route, only Marlborough and Framingham would be served directly by an I-290 extension. (The track runs through Southborough, but that town would not have a station under the plan proposed by the Marlborough Transportation Task Force.) In Marlborough the bus route serves the downtown business district, but the rail extension would stop at a park-and-ride facility in an industrial area near Route 495. (The rail line only passes through the edge of Marlborough, so there is no possibility of a downtown station.) In Southborough the bus route serves both the downtown area and a park-and-ride lot south of Route 9. The nearest station to Southborough on an I-290 extension would be at Routes 9 and 90 in Framingham. The latter site is close to an existing Mass. Turnpike park-and-ride lot, also served by the Gulbankian bus route.

The inbound A.M. peak trips leave the Mass. Turnpike at the Copley exit and makes stops at Copley Square, the State Transportation Building, and the State House. One

trip also continues to Park Street Station and the South Station area. In the P.M. peak there are two outbound trips serving all five Boston stops in the reverse order. In addition to peak-direction, peak-period service, there is one outbound A.M. peak trip to Marlborough and one to Southborough and there are two late afternoon inbound trips. (These trips are run mainly to shift buses between Boston and the company's garage in Southborough.)

Inbound peak scheduled running times to Copley Square range from 33 minutes at the Framingham park-and-ride lot to 45 minutes at Southborough Center, 55 minutes at downtown Marlborough, and 75 minutes at Hudson. (The running time from Framingham to Copley is consistent with CTPS timing run data for the Turnpike.) Additional running times to Boston stops after Copley range from 5 to 20 minutes.

Marlborough-Framingham Route

From September 1998 to August 1999, Gulbankian Bus Lines operated a route from Hudson through Marlborough and Southborough to the Framingham MBTA commuter rail station in addition to the through route to Boston. In February 2000 the Framingham LIFT system began operating a route (LIFT 7) from Marlborough to the Framingham Station on a slightly different alignment.

The Gulbankian Framingham route was the same as their Boston route from Hudson as far as the entrance to the Framingham park-and-ride lot. From there, the Framingham route continued on Route 9 to Framingham Centre. It then followed Main and Union streets to Framingham Station, with a stop at Framingham State College. Service on this route consisted of one round trip in the A.M. peak and one in the early evening. In the morning the inbound trip made a 5-minute connection with a train for Boston. The outbound trip made a 3-minute connection with a train from Boston or a 5-minute connection with a train from Worcester. In the evening the inbound trip did not have a good Boston connection but it had a 4-minute connection with a train to Worcester. The outbound trip had a one-minute connection with a train from Boston.

LIFT Route 7 starts at the Solomon Pond Mall and runs from there to downtown Marlborough. It then follows a route similar to that of the former Gulbankian route, except for some shifts to parallel roads in Southborough. As of Spring 2001, LIFT ran 16 round trips over the full route and one short-turn from downtown Marlborough on weekdays, with hourly service from early morning to late evening. Within Framingham, LIFT 7 replaced old LIFT 1, which ran from downtown Framingham to the Framingham Technology Park where it made a long one-way loop.

The scheduled running time for this route from downtown Marlborough to Framingham Station is 40 minutes. For comparison, the projected rail time to Framingham Station from an I-495/D'Angelo Drive station in Marlborough is 18 minutes. With Spring 2001 schedules, one LIFT bus trip allowed a connection with a train arriving in Boston before 9:00 A.M. Including a 15-minute wait at Framingham, total travel time from downtown Marlborough to South Station would have been 90

minutes. Two buses to Marlborough connected with outbound P.M. peak trains with waits of nine or ten minutes at Framingham.

Peter Pan Bus Lines Shopper's World Express and Route 9 Local Service

Effective in August 1999, Peter Pan Bus Lines consolidated service on their Worcester-Boston local route and their Framingham-Boston express route. Buses on the combined route run local on Route 9 from Worcester to the Edgewater Hills stop in Framingham where the express route began. (A stop has been added at the Mass. Turnpike park-and-ride lot at interchange 12 west of Edgewater.) Buses then continue on Route 9 to Shopper's World as the local and express routes both did. They then use the former express route on the Mass. Turnpike between Exit 13 in Framingham and Copley Square in Boston, continuing on local streets to Park Square, the State House, Post Office Square, and South Station. Outbound trips make the same stops in reverse order, omitting Post Office Square.

On this route the scheduled running time to Copley Square is 35 minutes from the stop nearest the assumed Framingham Centre/Salem End Road commuter rail station site and 42 minutes from the stop nearest the assumed Route 9 & 90/California Avenue station site. Scheduled times to other Boston stops range from 5 to 20 minutes longer.

Census and Survey Transit Ridership Totals from I-290 Extension Corridor

U.S. Census Journey-to-Work tabulations include breakdowns of work trips to Boston Proper, other Boston, and Cambridge from each city and town of residence, by mode of travel. Within modes, these figures do not indicate which route is used if there is more than one possibility, and commuters who alternate among two or more modes are counted under only one of them. Nevertheless, these data provide a general picture of the extent to which residents of individual cities and towns use mass transit to travel to work. Information on origins, destinations and trip purposes of passengers using MBTA commuter rail, express bus, and rapid transit lines is available from surveys conducted between 1993 and 1995. This provides a cross-check on the Census data. Results for towns in the service area of an I-290 extension from Framingham Station are summarized below. (Total commuter rail trips for all purposes from the same towns based on 1993 survey results appear in Table 2-1 in this report.)

Framingham

Of the three cities or towns that would be served directly by an I-290 extension, Framingham has by far the largest population and it generates the largest number of Boston and Cambridge work trips. It is also the only one of the three already served directly by a commuter rail line. The 2000 U.S. Census found a population of 66,910 in Framingham. This was a gain of 3.0%, reflecting recovery after several years of decline that followed the late 1980s closing of the General Motors Assembly Plant in the town.

According to the 1990 Census figures, Framingham originated 4,499 work trips to all of Boston or Cambridge, of which 751 (16.7%) were made by mass transit. Of these, commuter rail captured the largest share, with 526 (11.7%), followed by express bus with 183 (4.1%), and trolley or subway with 42 (0.9%). Since 1990 commuter rail service to Framingham has been improved by the introduction of peak-period express service, but there has been a substantial reduction in the frequency of bus service to Boston.

Results of the 1993 commuter rail survey (also conducted before the start of express train service) were fairly consistent with the Census data, showing 458 work trips from Framingham to Boston or Cambridge by that sub-mode alone. (This was equivalent to 10.2% of the Census total by all modes.) Survey results from 1994 showed 84 work trips from Framingham to Boston or Cambridge on MBTA rapid transit lines or the Green Line, excluding passengers transferring to these lines from commuter rail. This was twice as large as the number shown in the Census. Some of the discrepancy between Census and survey data may have resulted from rapid transit users in the Census sample incorrectly identifying their mode as commuter rail. Passenger counts or survey results for express buses from Framingham from the early 1990s are not available, but the Census figures appear to have been low relative to the amount of service that was still being operated at that time. Spring 2000 surveys showed a total of about 40 inbound Framingham riders on all private-carrier express bus routes for all trip purposes, with most of these making work trips.

Marlborough

Marlborough has the second-largest population of the three cities and towns that would be served directly by an I-290 extension and also ranks second in the number of Boston and Cambridge work trips generated. The 2000 U.S. Census found a population of 36,255 in Marlborough. This was an increase of 14.0% compared with 1990.

According to the 1990 Census figures, Marlborough originated 893 work trips to all of Boston or Cambridge, of which 73 (8.2%) were made by mass transit. Of these, commuter rail captured the largest share, with 48 (5.4%). The remaining 25 (2.8%) were all reported as using express buses.

The 1993 commuter rail survey results were consistent with the Census figure, showing 55 work trips from Marlborough to Boston or Cambridge by that sub-mode alone. (This was equivalent to 6.2% of the Census total by all modes.) In the survey, the most common commuter rail boarding station for Marlborough residents was Framingham, which accounted for slightly over half of the boardings for all trip purposes combined. The remainder were scattered among several stations on the Framingham / Worcester and Fitchburg lines.

Survey results from 1994 showed 33 work trips from Marlborough to Boston or Cambridge on MBTA rapid transit lines or the Green Line, excluding passengers transferring to these lines from commuter rail. This was in contrast with the Census figures, which indicated no use of rapid transit of the Green Line for work trips by

Marlborough residents. It is unclear why the Census did not find any rapid transit or Green Line users, but some of those surveyed in 1994 may have had different travel modes or different residences in 1990. The 1990 Census total for express bus use is consistent with information available from other survey or count data from around that time. Spring 2000 survey and Fall 2000 count results indicate about 30 to 35 Marlborough residents per day on all private-carrier express bus routes for all trip purposes, with most of these making work trips.

Northborough

Northborough has the smallest population of the three cities and towns that would be served directly by an I-290 extension and also ranks third in the number of Boston and Cambridge work trips generated. The 2000 U.S. Census found a population of 14,013 in Northborough. This was an increase of 17.5% compared with 1990. According to the 1990 Census figures, Northborough originated 257 work trips to all of Boston or Cambridge, of which 17 (6.6%) were made by mass transit. Of these, commuter rail captured the largest share, with 10 (3.9%). The remaining 7 (2.7%) were all reported as using express buses.

The combined 1993 and Worcester commuter rail survey results were consistent with the Census figures, showing nine work trips from Northborough to Boston or Cambridge by that sub-mode alone. In the survey, the most common commuter rail boarding station for Northborough residents was Framingham, which accounted for 7 of the 9 boardings. The other two boardings took place at Worcester Station. (There were no non-work trips by commuter rail from Northborough.) A January 2001 license plate survey at the new Grafton Station found 23 vehicles from Northborough there at midday. These probably included some diversions from older stations.

The 1994 survey results showed seven work trips from Northborough to Boston or Cambridge via the Green Line (all boarding at Riverside), but none via the rapid transit lines. The Census total for express bus use from Northborough is consistent with the available information on ridership on the bus route serving that town at the time. MBTA express bus surveys had no returns from Northborough residents. Spring 2000 survey and Fall 2000 count results show six Northborough residents per day on all private-carrier express bus routes for all trip purposes, with most of these making work trips. (Only two of these riders used the route that serves Northborough directly.)

Southborough

The I-290 extension would run directly through Southborough. The 1990 feasibility study and the 1994 PMT update both assumed that there would be a station in Southborough near the town center. The Marlborough Transportation Task Force proposal does not include a station in Southborough, partly because a station in that town is to be added on the Framingham / Worcester Line. There would also be good road access from Southborough to a station on the I-290 extension at Routes 9 and 90 in Framingham.

Southborough has a much smaller population than any of the three cities and towns that are assumed to have stations on an I-290 extension. The 2000 U.S. Census found a population of 8,781 in Southborough. This was an increase of 32.5% compared with 1990. It was the largest growth rate of any community that would be served directly or indirectly by the extension, but Marlborough and several of the towns in the indirect service area all showed larger absolute gains.

According to the 1990 Census figures, Southborough originated 364 work trips to all of Boston or Cambridge, of which 13 (3.6%) were made by mass transit. These were all shown as being made by commuter rail. The transit share looks too low for that time, as there was also express bus service to Boston from Southborough. The 1993 survey results showed 26 Boston and Cambridge work trips from Southborough by commuter rail, or twice the number indicated in the Census. Most of the boardings were made at Framingham Station, with a small number at West Natick. No Southborough residents were found in surveys of MBTA express bus riders. Four Southborough residents traveled to work via the Red Line, excluding transfers from commuter rail. Spring 2000 survey results show 23 Southborough residents using private-carrier express bus service, with most of these making work trips. Some of them may have shifted recently from other transit alternatives as a result of increased bus frequency.

Other Towns in Extension Service Area

As discussed in chapter 2, all or nearly all of the ridership on an I-290 extension that did not originate in one of the cities or towns that the line would run through would originate in one of ten neighboring towns. These are Sudbury, Hudson, Berlin, Boylston, Shrewsbury, Westborough, Ashland, Bolton, Lancaster, and Clinton. Historically most of these towns have not had a heavy Boston or Cambridge work-trip orientation.

Sudbury

In the 1990 Census figures Sudbury had the largest absolute number of Boston and Cambridge work trips of the ten towns in this group, at 1,047. The 2000 U.S. Census found a population of 15,937 in Sudbury, or an increase of 17.3% from 1990. Of the total 1990 Boston and Cambridge work trips from Sudbury, 109 (10.4%) were made by mass transit, with 51 of these shown as being on commuter rail, 36 on rapid transit, and 22 on express buses. In contrast, the 1993 survey showed 92 Boston and Cambridge work trips from Sudbury by commuter rail. The majority of the survey boardings took place at stations on the Fitchburg Line, with the largest number being at Lincoln.

The 1994 surveys found 42 Boston or Cambridge work trips from Sudbury via the Green or Red lines, or only slightly more than the Census figure, but about 40 via MBTA express buses. Spring 2000 survey results show only four Sudbury residents using private-carrier express bus service for all trip purposes combined. Discrepancies between the Census and survey results may have been partly because of new

commuters moving to Sudbury after 1990, and partly because of variations in the accuracy of the samples from which the figures above were expanded.

Ashland

In the 1990 Census figures Ashland had the second-largest absolute number of Boston and Cambridge work trips of the ten towns in this group, at 1,005. The 2000 U.S. Census found a population of 14,601 in Ashland, or an increase of 21.6% from 1990. Only a small portion of the town would be served by an I-290 extension, however.

Of the total 1990 Boston and Cambridge work trips from Ashland, 204 (20.3%) were made by mass transit, with 191 of these shown as being on commuter rail, and the rest on express buses. In contrast, the 1993 survey showed only 156 Boston and Cambridge work trips from Ashland by commuter rail. Almost all of the survey boardings took place at stations on the Framingham / Worcester Line, with the largest numbers being at Framingham (100) and West Natick (38).

The 1994 surveys found only two Boston or Cambridge work trips from Ashland via the Green Line and none via the Red Line, and four on MBTA express buses from Riverside. Spring 2000 survey results show only one Ashland resident using private-carrier express bus service for all trip purposes combined. Discrepancies between the Census and survey results may have been partly because of variations in the accuracy of the samples from which the figures above were expanded and partly because of changes after 1990 in the transit options available.

Westborough

In the 1990 Census figures Westborough had the third-largest absolute number of Boston and Cambridge work trips of the ten towns in this group, at 438. The 2000 U.S. Census found a population of 16,608 in Westborough, or an increase of 27.3% from 1990. The majority of Westborough residents would be more likely to use the new station being built in that town on the Framingham / Worcester Line than any station on an I-290 extension, however.

Of the total 1990 Boston and Cambridge work trips from Westborough, 52 (11.9%) were made by mass transit, with 24 of these shown as being on commuter rail, and the rest on express buses. In contrast, the 1993 survey showed 46 work trips from Westborough by commuter rail, all to Boston. Almost all of the survey boardings took place at stations on the Framingham / Worcester Line, with the largest share being at Framingham (29). A January 2001 license plate survey at the new Grafton Station found 53 vehicles from Westborough there at midday. These probably included some diversions from older stations.

The 1994 surveys found no Boston or Cambridge work trips from Westborough via the Green or Red Lines, which is consistent with the Census figure, and only six via MBTA express buses. Spring 2000 survey results show only four Westborough residents using

private-carrier express bus service for all trip purposes combined. None of these were on the route that served Westborough directly. As in other towns, discrepancies between the Census and survey results may have been partly because of variations in the accuracy of the samples from which the figures above were expanded and partly because of changes after 1990 in the transit options available.

Hudson

In the 1990 Census figures Hudson had the fourth-largest absolute number of Boston and Cambridge work trips of the ten towns in this group, at 393. The 2000 U.S. Census found a population of 18,648 in Hudson, or an increase of 5.1% from 1990. Of the total 1990 Boston and Cambridge work trips from Hudson, 29 (7.4%) were made by mass transit, with all of these reportedly on commuter rail. This was fairly consistent with the 1993 survey, which showed 22 Boston and Cambridge work trips from Hudson by commuter rail. Most of the survey boardings took place at stations on the Fitchburg Line, with the largest number being at South Acton.

The 1994 surveys found an additional 21 Boston or Cambridge work trips from Hudson via the Green or Red lines, but none via MBTA buses. Spring 2000 survey results showed 11 Hudson residents using private-carrier express bus service, with most of these making work trips. Discrepancies between the Census and survey results may have been partly because of new commuters moving to Hudson after 1990. Also, some Green or Red line users may have been incorrectly recorded as commuter rail users in the Census results.

Shrewsbury

In the 1990 Census figures Shrewsbury had the fifth-largest number of Boston and Cambridge work trips in this group of towns, at 314. The 2000 U.S. Census found a population of 31,640 in Shrewsbury, or an increase of 31.0% from 1990. This was one of the largest rates of growth in the seven-town group, and was the result of the largest absolute gain (7,494) in the entire extension service area. The 1990 Census figures showed that of the total Boston and Cambridge work trips from Shrewsbury, 17 (5.4%) were made by mass transit, with all of these reportedly on express buses.

This result pre-dated the startup of commuter rail service to Worcester. The 1993 commuter rail survey also pre-dated Worcester service, but showed 17 Boston and Cambridge work trips from Shrewsbury by commuter rail. Most of the passengers used trains that then terminated in Framingham, with Framingham Station being the largest single boarding location. The 1995 Worcester commuter rail survey showed 38 Boston or Cambridge work trip boardings from Shrewsbury at Worcester, including five diversions from previously existing commuter rail service and two diversions from express buses. A January 2001 license plate survey at the new Grafton Station found 73 vehicles from Shrewsbury there at midday. These probably included some diversions from older stations.

The 1994 survey results showed 25 work trips to Boston or Cambridge from Shrewsbury via the Green Line and another seven on the Red Line, excluding transfers from commuter rail. None of these were reported to have diverted to commuter rail in the Worcester survey. The large discrepancy between the Census and survey results may have been partly because of new commuters moving to Shrewsbury after 1990. Shrewsbury was not served directly by any express bus service in 1990, but did have a local-stops bus route to Boston that included some trips at times suitable for Boston work travel. Service on this route was reduced to off-peak hours only in 1997, but in 1999 it was combined east of Framingham with an express route and the schedule was shifted to peak hours. Nevertheless, Spring 2000 survey results found only two Shrewsbury residents using the route.

Clinton

In the 1990 Census figures Clinton had the sixth-largest number of Boston and Cambridge work trips in this group of towns, at 130. The 2000 U.S. Census found a population of 13,435 in Clinton, or an increase of 1.6% from 1990. This was the lowest growth rate of any community in the I-290 extension service area. In absolute terms, only Berlin had a smaller increase, but Clinton had a much larger base total. The low population growth in Clinton was probably related to fluctuation in in-town employment, during the 1990s.

The 1990 Census figures did not show any use of mass transit for Boston or Cambridge work trips from Clinton. The combined results of the 1993 commuter rail survey and 1995 Worcester Station survey showed 21 such trips by that sub-mode, however. The 1994 surveys showed another eight Boston or Cambridge work trips from Clinton via the Red Line, excluding commuter rail transfers. Clinton is not served directly by any bus route to Boston, and does not have convenient access to express bus service in other towns, so the absence of bus users in the Census totals is reasonable. (Spring 2000 surveys also found no Clinton residents on express buses.) The discrepancies between Census and survey results for other mass transit alternatives may have occurred partly because some Clinton residents who were employed in or near Clinton in 1990 had to travel to Boston or Cambridge to get work by the time the surveys were conducted.

Boylston

In the 1990 Census figures Boylston was tied with Bolton for the seventh-largest number of Boston and Cambridge work trips in this group of towns, at 114. The 2000 U.S. Census found a population of 4,008 in Boylston, or an increase of 14.0% from 1990.
`

The 1990 Census figures did not show any use of mass transit for Boston or Cambridge work trips from Boylston. The 1993 commuter rail survey also had no responses for this purpose but the 1995 Worcester commuter rail survey showed one such trip. A January 2001 license plate survey at the new Grafton Station found three vehicles from Boylston there at midday. These may have included some diversions from older stations.

The 1994 surveys found no Boylston residents using the Green Line or Red Line as initial transit modes. Boylston is not served directly by any bus route to Boston, but survey results show two people from Boylston using MBTA express buses from Riverside. No Boylston residents were found on private-carrier express buses in the Spring 2000 surveys.

Bolton

In the 1990 Census figures Bolton was tied with Boylston for the seventh-largest number of Boston and Cambridge work trips in this group of towns, at 114. The 2000 U.S. Census found a population of 4,148 in Bolton, or an increase of 32.4% from 1990. This was the second-largest percentage gain of any town in the extension service area, but was only the ninth-largest absolute gain.

The 1990 Census figures showed mass transit being used for 39 Boston or Cambridge work trips from Boylston (34.2%). This was by far the largest mass transit share shown from any town or city in the I-290 extension service area. All of these trips were shown as being made by commuter rail. In contrast, the 1993 commuter rail survey showed only 21 Boston or Cambridge work trips from Bolton by that sub-mode. All of these were made via the Fitchburg Line, with South Acton being the most common boarding location. The 1994 surveys found 11 Bolton residents using the Red Line for Boston or Cambridge work trips. Some of these may have been recorded incorrectly as commuter rail trips in the Census totals. Bolton is not served directly by any bus route to Boston, and does not have convenient access to express bus service in other towns. MBTA express bus survey results did not include any responses from Bolton residents. No Bolton residents were found on private-carrier express buses in the Spring 2000 surveys. The absence of bus users in the Census totals is consistent with these conditions.

Lancaster

In the 1990 Census figures, Lancaster and Berlin were far behind the other five towns in this group in total Boston and Cambridge work trips, but Lancaster was slightly ahead of Berlin in this measure (48 vs. 46). The 2000 U.S. Census found a population of 7,380 in Lancaster, or an increase of 10.8% from 1990. (Some earlier projections had anticipated a net loss in consequence of the closing of Fort Devens, located partly within the town.

The 1990 Census figures did not show mass transit being used for any of the Boston or Cambridge work trips from Lancaster. In contrast, the 1993 commuter rail survey showed 13 Boston or Cambridge work trips from Lancaster by that sub-mode. All but two of these were made by boarding Fitchburg Line trains at South Acton. The 1994 surveys found seven Lancaster residents using the Red Line for Boston or Cambridge work trips. Lancaster is not served directly by any bus route to Boston, and does not have convenient access to express bus service in other towns. MBTA express bus survey results did not include any responses from Lancaster residents. No Lancaster

residents were found on private-carrier express buses in the Spring 2000 surveys. The absence of bus users in the Census totals is consistent with these conditions.

Berlin

In the 1990 Census figures Berlin had the smallest number of Boston and Cambridge work trips in this group of towns, but was only slightly behind Lancaster, at 46. The 2000 U.S. Census found a population of 2,380 in Berlin, or an increase of 3.8% from 1990.

The 1990 Census figures showed mass transit being used for three Boston or Cambridge work trips from Berlin (6.5%). All of these trips were shown as being made by commuter rail. The 1993 commuter rail survey and the 1995 Worcester Station survey results did not include any responses from Berlin residents. The 1994 surveys did, however show three Boston or Cambridge work trips from Berlin via the Red Line. Some of these may have been recorded incorrectly as commuter rail trips in the Census totals. Berlin is not served directly by any bus route to Boston, and does not have convenient access to express bus service in other towns. MBTA express bus survey results did not include any responses from Berlin residents. No Berlin residents were found on private-carrier express buses in the Spring 2000 surveys. The absence of bus users in the Census totals is consistent with these conditions.

APPENDIX B - DETAILS OF TRAVEL TIME COMPARISONS BETWEEN I-290/NORTHBOROUGH EXTENSION AND EXISTING OPTIONS

Travel times to Boston from stations on an I-290 / Northborough extension from Framingham are discussed in chapter 3 of this report. Table 3-1 compares these times with estimated driving times to Boston. This appendix contains additional travel time comparisons between an I-290 extension and present bus and rail alternatives.

Northborough

Comparisons with Bus Service

The existing Northborough-Boston bus route runs along Route 20 from Route 135 at the town center to the border of Marlborough. The only stop in Northborough shown in published schedules is the one at the town center, but a note says that buses may stop at any safe location along the route. Historically, the Northborough commuter rail station was also at the town center, but under the plan proposed by the Marlborough Transportation Task Force, the station would be at Colburn Street near the Route I-290 bridges over the rail line. The driving distance from the town center to this station site would be about two miles over local roads. Town residents who drive to Boston leaving Northborough via I-290 would pass directly by or close to the Colburn Street site. Population density is heaviest in the south half of the town, however. From there the fastest driving route to Boston would include Route 20 rather than I-290 to leave Northborough, and would not pass near Colburn Street.

A September 2000 count found only two outbound bus riders alighting in Northborough, with one at a stop near the Marlborough border and the other at the outer terminal. Information on their final destinations and egress modes from stops and was not obtained. For passengers starting from points south of Route 20 or west of Route 135, driving time to an I-290 railroad station would be about five minutes longer than that to a bus stop, including time to park and to pay for parking. From origins in the north half of the town, the access time advantage of the bus compared with the train would be smaller.

As shown in Table 3-1, the scheduled bus time from Northborough Center to South Station (80 minutes) is 24 minutes longer than the estimated train time from an I-290 station to South Station (56 minutes). At Back Bay, the time differential would drop to 19 minutes. The difference in access time at Northborough Center would reduce the overall difference in bus and train times by up to five minutes more. Finally, the bus time from boarding stops between Northborough Center and the Marlborough line would be at most about four minutes faster than times from the start of the route. In summary, for most trips from Northborough to Boston, commuter rail service configured as assumed in chapter 3 would save between 10 and 24 minutes of travel time compared with present bus service, but few trips from Northborough to Boston are now made via the bus.

Comparisons with Existing Commuter Rail Service

The most commonly used transit alternative for Northborough residents traveling to Boston or Cambridge is the Framingham / Worcester commuter rail line, accessed by driving to Framingham Station. This alternative captures only a slightly greater number of riders than the direct bus service, however. Scheduled running times to Boston from Framingham vary among trains, depending on the number of intermediate stops served. At present, scheduled times for trains stopping at all intermediate stations range from 47 to 50 minutes, with an average of 48.5. For express trains from Worcester omitting all stops between Framingham and Back Bay except West Natick or Natick the scheduled running time to South Station is 35 minutes. (The 1993 commuter rail survey was taken before the introduction of Worcester express service, and the 1995 survey did not include passengers boarding at Framingham.)

For I-290 extension trains running non-stop between Framingham and Back Bay, the fastest scheduled running time to South Station would be 30 minutes. (Some trains would take slightly longer depending on the number of other trains they needed to meet or overtake.) Passengers with origins in towns served by the I-290 extension could still drive to Framingham to board if it was to their advantage to do so. In the 1993 survey results, the average driving time to Framingham Station reported for trips starting in Northborough was 25.8 minutes. Coincidentally, this is the same as the estimated running time for a train from departing I-290 to departing Framingham Station, but in addition to the line-haul time, train riders from Northborough would have average access times of about five minutes to an I-290 station. Since passengers would pay significantly higher fares at Northborough than at Framingham (Zone 8 vs. Zone 5), the main attraction of an I-290 station for Northborough residents compared with existing commuter rail would be greater convenience of access.

New stations currently under design or construction between Framingham and Worcester on the Framingham / Worcester Line will provide additional travel alternatives from Northborough. Of these stations, the one nearest Northborough will be at Smith Parkway in Westborough. The driving time to that station from the center of Northborough will be about nine minutes. This would be 16.8 minutes less than the reported average driving time from Northborough to Framingham Station, or four minutes longer than the driving time to an I-290 station from Northborough Center. The projected train running time from leaving Westborough to leaving Framingham is 15 minutes, so a passenger from Northborough would achieve a net travel time saving of 1.8 minutes by boarding a Worcester train at Westborough instead of Framingham.

The four-minute access-time saving at Northborough would not offset the added 10.8-minute train running time to Framingham from I-290 compared with Westborough. Additional differences between times via Westborough and times via I-290 would depend on operating strategies between Framingham and Boston. With Worcester trains continuing to stop at West Natick or Natick and I-290 trains running non-stop to Back Bay, I-290 trains would be up to five minutes faster east of Framingham. Northborough passengers would still save nearly two minutes on average by boarding

at Westborough instead of at I-290. Based on mileage from Boston, Westborough would also have lower fares than I-290 (Zone 7 vs. Zone 8). Therefore, as in the comparison with Framingham Station, I-290 would have to attract Northborough riders mainly on the basis of convenience of access.

Marlborough

Comparisons with Bus Service

As discussed in chapter 2 and appendix A, two separate bus routes connect Marlborough with Boston at present. One route traverses the city from west to east via Route 20. Another runs through the city from north to south via Route 85 and parallel roads. Both of these routes include several stops in downtown Marlborough and have service oriented for Boston work trips. A third route with service oriented for reverse commuting to Marlborough from Boston was run from 1998 to 2001, but discontinued because of low ridership. It had several stops in the industrial and office park areas along Route I-495 in the southwest section of the city.

From the center of the Marlborough business district to South Station, buses running via the west-east route have a scheduled time of 70 minutes. Buses running via the north-south route have a scheduled running time of 75 minutes to South Station, but offer lower fares. A September 2000 count found nine riders alighting from the west-east route in Marlborough, with all but one using stops east of the city center. Spring 2000 survey and count results showed 17 riders boarding the north-south route at stops in Marlborough, with the greatest concentration of these being near the city center.

Historically rail passenger service to downtown Marlborough from Framingham was provided via a dead-end branch line that diverged from the route of an I-290 extension at the border of Southborough and Marlborough. This branch was dismantled in the 1960s and portions of the right-of-way have been obliterated by new construction. Therefore, any future commuter rail station within Marlborough would have to be somewhere on the edge of the city. Under the plan proposed by the Marlborough Transportation Task Force, the station would be near the crossing of D'Angelo Drive about 0.8 miles west of I-495.

The fastest driving route to a D'Angelo Drive station from downtown Marlborough would use a combination of Route 20, I-495, the recently opened I-495 interchange and access road, and Crane Meadow Road. Including time to park, access time to the station from the center of the business district via this route would be about 9.5 minutes.

The estimated train time from the D'Angelo Drive station to South Station with trains running non-stop between Framingham and Back Bay is 49 minutes. When compared with the scheduled bus times from downtown Marlborough to South Station (70 to 75 minutes) the line-haul difference of 21 to 26 minutes in favor of the train would be more than twice the 9.5-minute access time advantage of the buses. For travel from Marlborough to Copley Square, the rail time advantage would narrow by 5 minutes for

the east-west bus route, reducing the differential to 6.5 minutes. For the north-south route, the rail time advantage at Copley Square would narrow by 15 minutes, to 1.5 minutes. In general, the further south or east of downtown Marlborough the trip origin point was, the smaller the travel time advantage of rail compared to bus would be. As noted above, however, relatively few trips from Marlborough to Boston are made by bus.

In addition to the through bus service to Boston, Marlborough is served by a feeder bus route to the Framingham commuter rail station. The scheduled time to Framingham Station from downtown Marlborough is 40 minutes. One morning trip has a scheduled 15-minute wait at Framingham for a limited-stops train with scheduled times of 35 minutes from there to South Station or 30 minutes to Back Bay. This would result in total travel times from Marlborough of 90 minutes to South Station or 85 minutes to Back Bay. The South Station time would be 15 to 20 minutes longer than those for the through bus routes. The Back Bay times would be 25 to 30 minutes longer than through bus times.

Comparisons with Recent Reverse-Commuting Bus Service

The reverse-commuting bus route that ran from 1998 to 2001 served employment areas along Route I-495 rather than downtown Marlborough. The stop nearest the proposed D'Angelo Drive rail station site was at Simarano Drive and Crane Meadow Road. The scheduled bus running time to there from South Station was 71 minutes. Spring 2000 figures showed only one to three riders each way per day on this route.

As discussed in chapter 3, reverse-commuting train service from Boston to points on an I-290 extension would be likely to include stops in Wellesley and Natick to pick up workers living in or near those towns. This, combined with schedule constraints in meeting peak-direction trains, would results in a running time of approximately 55 minutes from South Station to D'Angelo Drive for reverse commuting. This would be 16 minutes faster than the scheduled time on the reverse-commuting bus route between South Station and the stop nearest D'Angelo Drive. From Copley Square the differential would be only six minutes. The bus stops directly at several office or industrial parks. The closest the railroad station site is to any of these is about one half mile, or a 10-minute walk.

The results of the 1993 survey indicate that relatively few commuter rail riders are willing to walk more than 10 minutes at either trip end. At the outer trip end, only 27% of all riders accessed their boarding stations by walking, with almost all of the rest driving or being dropped off. Among those that walked to stations, only 23% walked for longer than 10 minutes, and only 4% for longer than 20 minutes. Overall only 6% of all commuter rail trips included walking access longer than 10 minutes. In the Old Colony survey among riders with walking access, 6.5% walked for longer than 20 minutes, but only 10% of all riders walked.
At the inner trip end, where the choice for most commuter rail passengers is walking or using connecting MBTA service, 60% of those in the 1993 survey walked to their final

destinations. Nevertheless, among those that walked only 28% walked for longer than 10 minutes and only 2% for longer than 20 minutes. Overall only 17% of all commuter rail trips included walking egress longer than 10 minutes. Similarly, in the Old Colony survey, 64% of passengers alighting at South Station walked to their final destinations, but just under 2% of these walked for more than 20 minutes. The findings above imply that reverse-commuting rail service to a D'Angelo Drive Station would need to have connecting shuttle bus or van service to major employment centers in order to attract a significant market share.

As of Spring 2001, there was no direct bus service to most of the employment areas along I-495 in Marlborough. The only service from Boston crossed I-495 on Route 20, and schedules were not convenient for the most common work shifts. LIFT Route 7 provided a connection from Framingham Station to the western half of Route 20 in Marlborough and to the Solomon Pond Mall, but like the Boston route it did not go directly into the office parks on ether side of Route 20 along I-495.

One outbound A.M. peak trip on LIFT Route 7 made a five-minute connection with an outbound express train at Framingham, but total travel time from South Station to I-495 at Route 20 in Marlborough would have been 90 minutes. Most reverse commuters would have had long walks from Route 20 to their work locations. There was no connecting bus service to the I-495 employment areas from any other commuter rail stations. All existing commuter rail stations are beyond feasible walking distance from any point in Marlborough.

A reverse-commuting train to D'Angelo Drive with a closely coordinated bus connection could provide total travel time from South Station to downtown Marlborough in a minimum of about 66 minutes. Relatively few reverse-commuting jobs in Marlborough are in the downtown area, however.

Comparisons with Existing Commuter Rail Service

The most commonly used transit alternative for Marlborough residents traveling to Boston or Cambridge is commuter rail, with the largest number of the passengers driving to Framingham Station on the Framingham / Worcester Line. In the 1993 survey results, the average driving time to Framingham Station reported for trips starting in Marlborough was 21.8 minutes. The estimated running time for a train from departure at D'Angelo Drive to Departure at Framingham is 18.8 minutes, but average access time of 9.5 minutes would have to be added to this. Therefore, a passenger starting a trip from Marlborough would save 6.5 minutes of travel time by boarding at Framingham Station instead of boarding the same train at D'Angelo Drive. The fares at Framingham would also be lower (Zone 5 versus Zone 7). The main attraction of a D'Angelo Drive station for Marlborough residents compared with existing commuter rail would be greater convenience of access.

Marlborough residents would also have the option of boarding I-290 trains at the Route 9 & 90 station. The average driving time to there would be about 12 minutes, or 2.5

minutes longer than access time to D'Angelo Drive. Train time to Boston from the Route 9 & 90 station would be 10 minutes less than from D'Angelo Drive, resulting in a net saving of 7.5 minutes at Route 9 &90. This would be a saving of one minute compared with driving all the way to Framingham Station to board, but the fare would be higher at Route 9 & 90 (Zone 6 versus Zone 5).

Of the new stations under construction on the Framingham / Worcester Line between Framingham and Worcester, the nearest one to Marlborough would be at Route 85 on the southern border of Southborough. Based on 1998 travel time runs, the driving time to that station from the center of Marlborough will be about 12 minutes. This would be 9.8 minutes less than the reported average driving time from Marlborough to Framingham Station, or 2.5 minutes longer than the driving time to a D'Angelo Drive station from downtown Marlborough. The projected train running time from leaving Southborough to leaving Framingham is 8 minutes, so a passenger from Marlborough would achieve a net travel time saving of 1.8 minutes by boarding a Worcester train at Southborough instead of Framingham.

The 2.5-minute access-time saving at D'Angelo Drive would not offset the added 10.8-minute train running time to Framingham from there compared with the time from Southborough. Depending on the operating strategy east of Framingham, the difference between the two alternatives could be narrowed by as much as 5 minutes on that segment. In that case, Marlborough passengers would still save an average of 3.3 minutes by boarding at Southborough instead of D'Angelo Drive. Based on mileage from Boston, Southborough would also have lower fares than I-290 (Zone 6 vs. Zone 7). Therefore, as in the comparison with Framingham Station, D'Angelo Drive would have to attract Marlborough riders mainly on the basis of convenience of access.

Access time from Marlborough to a Route 9 & 90 station would be the same as that to the Southborough station, but on-train time to Framingham would be one minute less from Route 9 & 90. Therefore, the difference between these stations in travel times to Boston would depend mostly on the operating strategy for trains east of Framingham. Both stations would be in Zone 6.

Framingham

Comparisons with Existing Commuter Rail Service

Of the three cities or towns that would have stations on an I-290 extension, only Framingham is currently served directly by a commuter rail line. The present Framingham Station is near the southeast corner of the town. For purposes of analysis, it is assumed that an I-290 extension would have two stations in Framingham. A California Avenue / Route 9 & 90 station would be near the southwest corner of the town. A Salem End Road / Framingham Centre station would be about halfway between the east and west borders of the town, but south of the north-south midpoint.

All trains that would stop at stations on the extension would also stop at the existing Framingham Station, which would be the closest to Boston of the three. Therefore, the extension stations would not attract trips from origins closer to the existing station. The attractiveness of the extension stations for trips from other Framingham origins would depend on the access time reduction relative to the on-train time increase.

The Framingham Centre station would be two miles north of Framingham Station. It would not attract riders with trip origins between the south edge of the town and points about one mile north of the Framingham / Worcester commuter rail line. For trips originating in the remainder of the town, the 1993 commuter rail survey results showed average access times to Framingham Station of 11.5 minutes. The driving time from the Framingham Centre station site to Framingham Station is about five minutes. Passengers who access Framingham Station by driving past Framingham Centre would reduce their access times by that amount by switching to a Framingham Centre station. From many points in the town, however, the most direct route to Framingham Station does not run past Framingham Centre. For passengers originating at such points, the access time reduction at Framingham Centre would be under five minutes. Therefore, the average access time to Framingham Centre from the parts of the town it served would be something in excess of 6.5 minutes.

The estimated train time from departing Framingham Centre to departing Framingham Station is 4.7 minutes, so even passengers getting maximum access time savings by diverting to Framingham Centre would achieve little overall travel time reduction. A Framingham Centre station would therefore have to attract riders more on the basis of convenience of access than of travel time savings.

With present road layouts and land-use patterns, very few Framingham residents would find access to a Route 9 & 90 station more convenient than that to Framingham Centre or Framingham Station. The driving time from the Route 9 & 90 station site to Framingham Station is about 12 minutes. The estimated running time for a train between the two stations is 9.0 minutes. Passengers whose access trips to Framingham Station would take them past the Route 9 & 90 station would therefore save about three minutes of overall travel time by using the new station. This would apply almost entirely to residents of towns other than Framingham, however.

Comparisons with Bus Service

As discussed in chapter 2 and appendix A, two separate bus routes connect Framingham with Boston at present. Both routes enter Framingham from the west on Route 9. One of the routes continues to Shoppers World on Route 9 making local stops (including one at the Mass. Turnpike park-and-ride lot at Interchange 12) then runs non-stop on the Mass. Turnpike from Interchange 13 to Boston. The second route makes a single stop in Framingham at the Turnpike park-and-ride lot and then runs non-stop to Boston on the Turnpike from Interchange 12.

The scheduled running time from the Interchange 12 park-and-ride lot to South Station on the faster of the two routes is 53 minutes. The estimated train running time to South Station from a California Avenue/Route 9 & 90 station, which would be a short distance from the park-and-ride lot, would be 39 minutes, or 14 minutes less than the bus time. The bus time to Copley Square (33 minutes) is one minute faster than estimated train time to Back Bay, however. Because of the stop location and relatively high fares, few if any, Framingham residents use the bus from the park-and-ride lot now. (Spring 2000 counts showed no boardings there on either bus route.)

The bus route that follows Route 9 to Shoppers World has a stop at Framingham Centre near the Salem End Road/Framingham Centre station site. From this stop, scheduled times to Boston are 55 minutes to South Station or 35 minutes to Copley Square. This compares with estimated train times of 35 minutes to South Station or 30 minutes to Back Bay. Spring 2000 counts showed only two inbound boardings at Framingham Centre, and another three at the Edgewater apartments, two minutes further west.

In addition to the through bus service to Boston, Framingham residents can use a combination of local bus routes and commuter rail for travel to Boston. These bus routes are part of the Local Inter Framingham Transportation (LIFT) system. They are operated on fixed headways, and schedules are not arranged for good connections with train service. Furthermore, they do not follow the most direct alignment to the station from most points.

As of Spring 2001, only one bus trip serving points in Framingham on the I-290 extension would have allowed passengers to reach Framingham Station early enough to connect with an A.M. peak train to Boston. This bus trip had scheduled times to the station of 22 minutes from the Mass. Turnpike park-and-ride lot and seven minutes from Framingham Centre, compared with estimated train times of nine and five minutes from the nearest extension stations. Passengers alighting from this bus at the stop nearest Framingham Station would have had to wait another 15 minutes for the next train. This was a limited-stops trip, with scheduled times of 35 minutes to South Station or 30 minutes to Back Bay from Framingham. Total travel time to South Station would have been 72 minutes from the park-and-ride lot, or 57 minutes from Framingham Centre.

In the P.M. peak, trains leaving Boston at 4:30 and 5:30 had LIFT bus connections with scheduled waits of 10 and 9 minutes at Framingham Station. These were both all-stops local trains with scheduled times of 50 and 51 minutes from South Station to Framingham Station. Bus running times from there were eight minutes to Framingham Centre or 20 minutes to California Avenue. This would have resulted in total travel times of 68 and 80 minutes from South Station.

A passenger boarding a train at a Salem End Road station would pay no additional fare compared with boarding at Framingham Station. For a passenger boarding a train at California Avenue/Route 9 & 90 instead of Framingham Station, the additional fare would range from 21 cents with a monthly pass to 25 cents with a single-ride ticket.

Passengers using LIFT buses to access Framingham Station would pay $1.50 for a single ride or 90 cents with a 20-ride ticket in addition to the train fare.

Southborough

Comparisons with Bus Service

An I-290 extension would run through Southborough, but would not include a station there under the Marlborough Transportation Task Force proposal. The 1990 feasibility study and the 1994 PMT analysis both assumed that there would be a station at Southborough Center. Such a station could still be included, but it would add about two minutes to running times at the Marlborough and Northborough stations. Without a station in Southborough itself, the nearest one would be the California Avenue/Route 9 & 90 station in Framingham, about one half mile east of the border between the two towns.

As discussed in chapter 2 and appendix A, Southborough was served by two express bus routes to downtown Boston in Spring 2001. From the bus stop nearest Southborough Center on the faster route, scheduled express bus times were 65 minutes to South Station or 45 minutes to Copley Square. This compares with estimated train times of 39 and 34 minutes from the Route 9 & 90 station. For passengers originating at points west or north of Southborough Center, access time to this railroad station would be about five minutes longer than that to the bus, making the net time savings for the train 21 minutes at South Station but only 6 minutes at Copley.

There was also feeder bus service from Southborough to Framingham Station operated as part of the LIFT system. The scheduled time from Southborough Center to Framingham Station was 33 minutes inbound and 32 outbound. Morning and evening train connections were the same as described above for Framingham Centre and California Avenue. This would have resulted in total inbound travel time from Southborough Center of 83 minutes to South Station or 78 minutes to Back Bay. Outbound, with connections only from local trains, the times to Southborough would be 92 minutes from South Station or 87 minutes from Back Bay.

The fare differential between all-rail service and bus-train service to Boston from California Avenue would be as discussed in the Framingham comparisons above.

Comparisons with Existing Commuter Rail Service

Among Southborough residents traveling to Boston or Cambridge by commuter rail, the largest number drive to Framingham Station on the Framingham/Worcester Line. In the 1993 survey results, the average driving time to Framingham Station reported for trips starting in Southborough was about 14 minutes. The average driving time to a Route 9 & 90 station from points in Southborough would be about 5 minutes, so the access time reduction would be 9 minutes. The estimated train time from the Route 9 & 90 station to Framingham Station is also 9 minutes, so the benefit of the Route 9 & 90

station for Southborough residents would be greater convenience rather than travel time reduction. For the added convenience, they would pay slightly higher rail fares (Zone 6 vs. Zone 5).

One of the new stations under design on the Framingham / Worcester Line will be at Route 85 on the southern border of Southborough. The access time to that station from Southborough Center will be about the same as the access time to a Route 9 & 90 station. The Southborough station would have an access time advantage from points southwest of the center, and the Route 9 & 90 station would have the advantage from points east of the center. The projected train time to Framingham Station from the Southborough station is eight minutes, or one minute less than the estimated time from Routes 9 & 90. Differences in overall travel times to Boston via the two stations would therefore depend mostly on the number of intermediate stops made east of Framingham by the trains serving them. Both stations would have Zone 6 fares.

Sudbury

Comparisons with Bus Service

Of the towns that are assumed to be in the service area of an I-290 extension but not served directly, Sudbury originated the largest number of Boston and Cambridge work trips in 1990. As discussed in chapter 2 and appendix A, Sudbury was served by one through bus route to downtown Boston in Spring 2001. From the most centrally located stop, at South Sudbury, scheduled bus times were 55 minutes to South Station or 45 minutes to Copley Square.

From Sudbury, the nearest station on an I-290 extension would be one at Framingham Centre. The driving time to there from the South Sudbury bus stop, including time to park, would be about 14 minutes. The estimated running time to South Station From Framingham Centre for a train making no intermediate stops between the downtown Framingham Station and Back Bay is 35 minutes. Therefore, excluding waiting time, the total travel time from South Sudbury via the rail extension would be about 49 minutes to South Station or 44 minutes to Back Bay. These would be six minutes and one minute faster than the scheduled bus times. Bus ridership from Sudbury on this route is negligible, however. A Fall 2000 count found only two Sudbury riders, with one at the South Sudbury stop and the other at a stop further east.

Comparisons with Existing Commuter Rail Service

The most commonly used transit alternative for Sudbury residents traveling to Boston or Cambridge is commuter rail, with the largest number of the passengers driving to Lincoln Station on the Fitchburg Line. In the 1993 survey results, the average driving time to Lincoln Station reported for trips starting in Sudbury was about 16 minutes. From South Sudbury, the time was about 18 minutes, compared with an estimate of 14 minutes to Framingham Centre. Trains from Lincoln go to North Station rather than South Station. Peak-period scheduled running times from Lincoln to North Station

average 37.5 minutes for trains stopping at most intermediate stations. This is 2.5 minutes longer than the estimated running time from Framingham Centre to South Station. The fastest limited-stops train from Lincoln to North Station takes 30 minutes, or five minutes less than the estimated time from Framingham Centre to South Station. Travel via Framingham Centre would be faster than travel via Lincoln on a local train from most points south of state Route 27, but travel on a limited-stops train from Lincoln would be faster from most points east or north of South Sudbury.

Sudbury residents would probably choose between Lincoln limited-stops trains and Framingham Centre trains on the basis of the proximity of the Boston stations to their final destinations. (Although the Fitchburg Line serves Cambridge directly, the 1993 survey found only four work trips from Sudbury to Cambridge by rail.)

Ashland

Comparisons with Bus Service

Of the towns that are assumed to be in the service area of an I-290 extension but not served directly, Ashland originated the second-largest number of Boston and Cambridge work trips in 1990. At present, there is no through bus service to Boston from Ashland. The nearest express bus stop from most origins in Ashland is at Framingham Centre. Scheduled bus times from there are 58 minutes to South Station or 38 minutes to Copley Square. The driving time to this stop from downtown Ashland, including time to park, would be about 12 minutes.

From Ashland, the nearest station on an I-290 extension would also be one at Framingham Centre, and the access route and time would be the same as to the bus stop. The estimated running time to South Station from Framingham Centre for a train making no intermediate stops between the downtown Framingham Station and Back Bay is 35 minutes. Excluding waiting time, the total travel time from Ashland on the train would be about 23 minutes faster to South Station and eight minutes faster to Copley Square than the time on the bus. Bus ridership from Ashland on this route is negligible, however. A Spring 2000 survey found only one Ashland rider.

Comparisons with Existing Commuter Rail Service

The most commonly used transit alternative for Ashland residents traveling to Boston or Cambridge is commuter rail, with the largest number of the passengers driving to the Framingham or West Natick stations on the Framingham / Worcester Line. In the 1993 survey results, the average driving time to Framingham Station reported for trips starting anywhere in Ashland was about 11 minutes. From downtown Ashland, the time would have been about seven minutes, compared with the estimated 12 minutes to Framingham Centre. At present, the scheduled time to South Station from Framingham Station for trains running non-stop between West Natick or Natick and Back Bay is 35 minutes. The assumed running time from Framingham Centre to South Station would be the same as this if I-290 trains ran non-stop from Framingham Station to Back Bay.

Ashland residents could also go to Framingham Station to board I-290 trains, which would take 30 minutes to South Station from there. Therefore, boarding at Framingham Centre would minimize travel times only for those Ashland residents from a small area along Myrtle Road near the northern border of the town.

One of the new stations under design on the Framingham / Worcester Line will be on Pleasant Street in Ashland, west of the town center. The access time to that station from downtown Ashland will be about four minutes, or three minutes less than the access time to Framingham Station. The additional train time from Ashland to Framingham will also be about three minutes. Therefore, passengers who would choose Framingham Centre over Framingham on the basis of total travel time would also choose Framingham Centre over Ashland Station. Framingham Centre would also have lower fares than Ashland (Zone 5 versus Zone 6).

Westborough

Comparisons with Bus Service

Of the towns that are assumed to be in the service area of an I-290 extension but not served directly, Westborough originated the third-largest number of Boston and Cambridge work trips in 1990. At present, bus service to Boston from Westborough is provided by a route that makes local stops along state Route 9 between Worcester and Shopper's World in Framingham and then runs to Boston on the Mass. Turnpike. Scheduled bus times from the stop nearest downtown Westborough, at Lyman Street, are 75 minutes to South Station or 55 minutes to Copley Square. The additional access time to this stop from downtown Westborough would be about four minutes. The Spring 2000 survey did not find any Westborough boardings on this route. Four Westborough residents did, however board another bus route at a park-and-ride lot in Southborough. From there, scheduled bus times were 60 minutes to South Station and 40 minutes to Copley Square. The access time to this stop from downtown Westborough would be about 11 minutes, so passengers going to Boston would save about eight minutes by boarding there instead of using the bus that stops in Westborough.

From Westborough, the nearest station on an I-290 extension would be the Route 9 & 90 station at California in Framingham. The fastest access path to this station would be via Route 9. From downtown Westborough this would take about 16 minutes. The estimated running time to South Station from Route 9 & 90 for a train making no intermediate stops between the downtown Framingham Station and Back Bay is 39 minutes. Excluding waiting time, the total travel time from downtown Westborough on the train would be about 16 minutes faster to South Station but only one minute faster to Copley Square than the time on the Southborough bus. As noted, however, only four passengers a day used the bus in the 2000 count.

Comparisons with Existing Commuter Rail Service

The most commonly used transit alternative for Westborough residents traveling to Boston or Cambridge is commuter rail, with the largest number of the passengers driving to the Framingham / Worcester Line. In the 1993 survey results, the average driving time to Framingham Station reported for trips starting anywhere in Westborough was about 22 minutes. The time from downtown Westborough would be about 25 minutes. The reduction in driving time by going to Route 9 & 90 instead of Framingham Station would be about the same as the added train time between these stations. Under the assumed operating plan, I-290 trains would be about five minutes faster than Worcester express trains between Framingham Station and Boston, however.

One of the new stations being built on the Framingham / Worcester Line will be at Smith Parkway in Westborough, west of the town center. The access time to that station from downtown Westborough will be about five minutes, or 11 minutes less than the access time to Route 9 & 90. Under the assumed operating plan, the running time to South Station would be about 50 minutes from Westborough Station compared with 39 minutes from Route 9 & 90. Therefore, including access time, total travel times from downtown Westborough would be the same via either alternative. Route 9 & 90 would have a net travel time advantage from origins east of Route 135 and Westborough Station would have an advantage from points west of that. Route 9 & 90 would have lower fares than Westborough Station (Zone 6 versus Zone 7). Segments of the town west of Route 135 have a larger share of population than those further to the east and are likely to continue to because of industrial areas and wetlands on the east side.

Hudson

Comparisons with Bus Service

Of the towns that are assumed to be in the service area of an I-290 extension but not served directly, Hudson originated the fourth-largest number of Boston and Cambridge work trips in 1990. As discussed in chapter 2 and appendix A, Hudson is currently served by one through bus route to downtown Boston. From the end of the route in downtown Hudson, scheduled bus times are 95 minutes to South Station or 75 minutes to Copley Square.

From downtown Hudson, driving time would be slightly less to an I-290 / Northborough station than to an I-495 / D'Angelo Drive station (11 minutes vs. 11.5), but I-495 would have the advantages of shorter train times and lower fares. Therefore, Hudson residents would be more likely to use the I-495 station. The estimated train times from there are 49 minutes to South Station or 44 minutes to Back Bay. Including access time, the train would give travel time savings of 34.5 minutes to South Station or 19.5 minutes to Copley compared with the bus. Very few Hudson residents use the bus, however.

The scheduled time for the feeder bus service from downtown Hudson to Framingham Station that operated from 1998 to 1999 was 60 minutes. The morning trip had a scheduled five-minute wait at Framingham for a limited-stops train with scheduled times of 43 minutes from there to South Station or 38 minutes to Back Bay. This would have resulted in total travel times from Hudson of 108 minutes to South Station or 103 minutes to Back Bay.

Comparisons with Existing Commuter Rail Service

The most commonly used transit alternative for Hudson residents traveling to Boston or Cambridge is commuter rail, with the largest number of the passengers driving to South Acton Station on the Fitchburg Line. In the 1993 survey results, the average driving time to South Acton Station reported for trips starting in Hudson was about 16 minutes. The average driving time to an I-495 station from points in Hudson would be 11.5 minutes, so the access time reduction would be 4.5 minutes. Trains from South Acton go to North Station rather than South Station. Peak-period scheduled running times from South Acton to North Station average 52.5 minutes for trains stopping at most intermediate stations. This is 3.5 minutes longer than the estimated running time from I-495 to South Station. The fastest limited-stops train from South Acton to Boston takes 46 minutes, or 3 minutes less than the estimated time from I-495. A future increase in the number of limited-stops trains serving South Acton is likely. Because of the relatively small overall time differences to the Boston terminals, Hudson residents would probably choose between South Acton limited-stops trains and I-495 trains on the basis of the proximity of the Boston stations to their final destinations. (Although the Fitchburg Line serves Cambridge directly, the 1993 survey found only two work trips from Hudson to Cambridge by rail.)

Shrewsbury

Comparisons with Bus Service

Of the towns that are assumed to be in the service area of an I-290 extension but not served directly, Shrewsbury had the largest total population but originated the fifth-largest number of Boston and Cambridge work trips in 1990. Bus service from Shrewsbury to Boston has been re-configured many times in the past 20 years. Under the most recent revision, implemented in 1999, buses originate in Worcester, run through Shrewsbury on Route 9, and continue on Route 9 to Shoppers World in Framingham. They then enter the Mass. Turnpike at Interchange 13 and run non-stop to Boston. The most centrally located stop in Shrewsbury is at South Street, east of Route 140. The scheduled running time from there to Boston is 80 minutes to South Station or 60 minutes to Copley Square. This route does not run directly through the heaviest concentrations of population in Shrewsbury. Passengers dropped off at a stop would have additional average access times of about three minutes. (Spring 2000 counts showed no boardings at the Shrewsbury stops.)

The most convenient boarding location on an I-290 extension for Shrewsbury residents would be the I-290 terminal, accessed via I-290 itself. The average driving time from Shrewsbury to this station would be about 11 minutes. The estimated train time from there would be 56 minutes to South Station or 51 minutes to Back Bay. Including access time, and assuming equal waiting times, the train would have a 16-minute advantage over the bus to South Station, but the bus would take only one minute longer to the Copley Square area.

Comparisons with Existing Commuter Rail Service

The most commonly used transit alternative for Shrewsbury residents traveling to Boston or Cambridge is commuter rail, with the largest number of the passengers driving to Worcester Station on the Framingham / Worcester Line. In the 1995 survey results, the average driving time to Worcester Station reported for trips starting in Shrewsbury was about 11 minutes, or the same as the estimated driving time to an I-290 / Northborough Station. At present, the fastest scheduled time for a train from Worcester to South Station is 68 minutes. This is for trains making only one intermediate stop (Grafton) between Worcester and Framingham, and making no intermediate stops except West Natick or Natick between there and Back Bay. Compared with this schedule, Shrewsbury passengers would save an average of 12 minutes to either South Station or Back Bay by diverting to I-290.

At present, three additional stations are under design or construction between Worcester and Framingham. (Another may be added in the future.) The extent to which the additional dwell times for these stations will be offset by track improvements is unclear, but some further increase in running times is likely. This would increase the relative advantage of I-290 compared with Worcester Station for Shrewsbury passengers.

Among the new stations to be added, the nearest one for most Shrewsbury residents would be the Westborough station. The average driving time to that station from Shrewsbury would be about 10 minutes, or one minute less than reported time to Worcester or estimated time to I-290. The projected train running time from leaving Westborough to leaving Framingham is 15 minutes, compared with an estimated 25.8 minutes from I-290, so Shrewsbury passengers would save an average of 11.8 minutes west of Framingham by boarding at Westborough instead of I-290. The difference in time to Boston would be 6.8 minutes if Worcester trains continued to stop at West Natick or Natick but I-290 trains ran non-stop from Framingham to Back Bay. Westborough would also have slightly lower fares than I-290 (Zone 7 vs. Zone 8). Therefore an I-290 station would be likely to attract only those Shrewsbury residents with homes much closer to I-290 than to Westborough.

Clinton, Bolton, and Lancaster

Comparisons with Existing Commuter Rail Service

Clinton, Bolton, and Lancaster are not served directly by either through bus service to Boston or feeder bus service connecting with any transit service to Boston. Based on survey data, the most commonly used transit alternative for residents of each of these towns traveling to Boston or Cambridge is commuter rail, with the largest number of the passengers driving to South Acton Station on the Fitchburg Line. In the 1993 survey results, the average reported driving times to South Acton Station were about 22 minutes from Clinton, 18.5 minutes from Bolton, and 23 minutes from Lancaster.

For most trips starting in any of these three towns, the most convenient boarding station on an I-290 extension would be the I-495/D'Angelo Drive station. The average driving time to this station would be 20.5 minutes from points in Clinton, 13.5 minutes from points in Bolton, and 20 minutes from points in Lancaster. These would be savings of 1.5, 5.0, and 3.0 minutes compared with driving to South Acton. As discussed above in the Hudson section, the estimated running time from I-290 to South Station would be 3.5 minutes less than the average scheduled time from South Acton to North Station for local trains but 3.0 minutes longer than the scheduled time for South Acton express trains. Therefore, Clinton, Bolton, and Lancaster residents would probably choose between South Acton limited-stops trains and I-495 trains on the basis of the proximity of the Boston stations to their final destinations. (Although the Fitchburg Line serves Cambridge directly, the 1993 survey found only three work trips from Clinton, five from Bolton, and one from Lancaster to Cambridge by rail.)

Berlin and Boylston

Berlin and Boylston are not served directly by either through bus service to Boston or feeder bus service connecting with any transit service to Boston. Berlin residents using an I-290 extension would board at either the I-290 or I-495 stations depending on the locations of their homes. Boylston residents would board at the I-290 station.

The number of Berlin and Boylston residents using existing commuter rail service according to survey and Census results is too small to allow meaningful direct comparisons with travel times via an I-290 extension. Based on the comparisons above for neighboring towns, most Berlin and Boylston residents would not perceive that an I-290 extension significantly improved travel times to Boston compared with other transit alternatives.

APPENDIX C - FURTHER DETAILS ON ROLLING STOCK REQUIREMENTS FOR I-290/NORTHBOROUGH EXTENSION

Rolling stock requirements for each I-290 / Northborough extension alternative were calculated in terms of the number of locomotives and coaches that would be required to operate the schedule including the extension but would not be required without it. For the alternatives using push-pull equipment, each new train set would have one locomotive. Coach requirements were based on provision of seats for peak-period riders, using double-deck coaches with 185 seats each. (These estimates may be low, as demand would not necessarily divide among trains in even multiples of 185.) As discussed in chapter 6, minimum train-length requirements dictated by the present operating policy on South Side lines would require more coaches for most alternatives than would be required by capacity considerations alone.

The assumed schedules for service on an I-290 extension either with or without reverse-commuting service would include four inbound A.M. peak trains and four outbound P.M. peak trains. (This is the maximum that could be provided along with planned frequencies of Worcester and Framingham trains.) Even with I-290 trains running non-stop between Framingham and Back Bay, no train set could complete a round trip between I-290 and South Station fast enough to cover more than one peak-direction departure in either peak period. Therefore four train sets would be needed to operate four peak-direction trips. Three of the same train sets would also be available to provide three reverse-commuting trips in each peak. A fifth set would be required to provide a fourth reverse-commuting trip. The peak equipment requirements on an I-290 extension would occur at the same times as those on other lines, so it would not be possible to serve the extension with equipment that would otherwise be sitting idle.

Based on the ridership forecasts in chapter 4, A.M. peak inbound ridership at year 2000 levels would average about 1,675 per day. But with typical day-to-day fluctuations it could range up to about 1,925. This would be slightly more than the capacity of 10 double-deck coaches. The most-heavily used of the four peak trains would each carry up to 30% of these riders, or 575, requiring three coaches. At present, none of the double-deck cars in the fleet is lavatory-equipped, so every train is assigned at least one single-level 95 or 99 seat coach with a lavatory. A three-car train with one such car and two double-deckers, would have only about 470 seats, so the minimum configuration would be two double-deckers and two single-level cars. (Rather than purchasing new single-level cars, new double-deckers would probably be purchased and swapped for single-level cars on other trains that need added capacity.)

Four-car sets would be less than the six-car minimum standard used by the MBTA on South Side lines, so a total of 24 coaches would be needed for four sets or 30 coaches for five sets. If I-290 service were implemented it could not occur until sometime after 2001. The demand forecasts indicate that ridership would increase by about 26% between 2000 and 2020. This would raise the capacity requirement for peak trains to about 735 each, requiring either one single-level car and four double-deckers, or two

single-level cars and three double-deckers. In either case, the minimum six-car sets called for by present operating policy would still be sufficient by the year 2020.

Some of the riders on an I-290 extension would be diverted from other commuter rail lines, reducing the capacity requirements on those lines. Most of the diversions would come from either the Framingham / Worcester Line or the Fitchburg Line. As of Spring 2001, the Framingham / Worcester Line had nine trips arriving in Boston between 6:30 and 9:30 A.M. Of these, five were scheduled to have seven-car sets, and three were scheduled to have six-car train sets. The last train due at 9:28 had a five car set because of equipment shortage, although this was less than the South Side standard of six cars. No individual train set was used on more than one of the nine trips, but some of the sets also made peak trips on other lines.

Full implementation of Worcester service will occur before I-290 service could start. Tentative schedules indicate that there will be no increase in the total number of train sets used in A.M. peak service compared with the Spring 2001 schedule. Without a much more detailed analysis, it is impossible to predict how these sets would be shared with other routes, but the Spring 2001 equipment cycle plan provides an example. Even if ridership on Worcester and Framingham trains was reduced because of diversions to I-290 trains, the six-car and five-car sets used in Spring 2001 could not have been shortened without violating present standards for South Side service. Two of the seven-car sets were also used on A.M. peak Attleboro / Stoughton Line trains, which determined their capacity requirements. This would have left only three seven-car sets as possible candidates for reduction to six cars after I-290 diversions. Diversions of riders to an I-290 extension from the Fitchburg Line would be too small and distributed over too many trains to allow for any train-length reductions on that line.

If an I-290 extension were run with Diesel Multiple Unit (DMU) cars rather than locomotive-hauled trains, it is unclear what the capacity per car would be. At present, the only commuter rail operations in the United States that use DMUs are single-route systems in Dallas / Forth Worth Texas and in Rochester, New York. Both of these use Budd Rail Diesel Cars (RDCs) originally built in the 1950s and extensively overhauled for their present uses. These cars have about the same amount of interior space as the MBTA's single-level commuter rail cars, which would allow a maximum of about 120 seats in three-and-two configuration. Any DMUs used for I-290 service would probably also be single-level cars with dimensions similar to these. Therefore, for purposes of analysis, capacities of 120 per car were assumed.

At the estimated year 2000 demand level, A.M. peak ridership would be equal to the capacity of 16 DMUs. The most heavily patronized trains would need five cars each. For flexibility in equipment assignment, it is assumed that for service including four peak-direction trains, all four sets would have five cars, making a total of 20. A fifth set needed for maximum reverse-commuting service could be limited to two cars. Since these cars would not be interchangeable with the rest of the commuter rail fleet, separate spares would need to be provided to allow for routine maintenance and

inspections. With a 10% spare ratio, this would add two more cars with either four or five sets, making the respective fleet totals 22 or 24.

Ridership growth between the years 2000 and 2020 would raise the required lengths of the most heavily used trains from five cars each to six. This would requires additional rolling stock. Based on current cost information, DMU trains of five cars are slightly less expensive to operate than locomotive-hauled six-car trains, but trains of six or more DMUs are more costly. Overall savings from use of DMUs would depend on the amount of off-peak and weekend service run with shorter trains compared with the amount of peak service run with full-length sets.

APPENDIX D - FURTHER DETAILS ON OPERATIONAL ISSUES

Impacts of I-290 Extension on Framingham/Worcester Line

The Framingham / Worcester commuter rail line is mostly double-tracked, but there is a 1.7-mile single-track section adjoining the CSX Beacon Park freight yard in Allston. On the double-track segments, the tracks are numbered 1 and 2 from north to south. signaling on both tracks allows trains to operate in either direction on either track. Crossovers at a point known as CP-11 between Wellesley Farms and Auburndale allow trains in either direction to change tracks. Trains can also change tracks at CP-21 just east of Framingham Station.

With conventional right-hand running, Track 1 would be outbound and Track 2 would be inbound. Because of the present platform layouts at several stations, however, trains in either direction making local stops are run on Track 2 if possible. At Newtonville, West Newton, and Auburndale there are platforms only on the Track 2 side. When trains stop on Track 1 at these stations, passengers must cross Track 2 on narrow boardwalks to board or alight. All other stations on the line have platforms for both tracks, but at Wellesley Hills and West Natick the Track 1 platforms can be accessed only by walking across both tracks from the opposite platforms. At Wellesley Farms it is also possible to cross the tracks by a road bridge, but most passengers use the parking lot adjoining Track 2 and also walk across both tracks when going to or from the Track 1 platform. These platform arrangements place constraints on the locations and times at which trains on one track can be scheduled to pass trains on the other.

Typically, when trains on Tracks 1 and 2 are scheduled to be in the same station at about the same time, the second train to arrive is held outside the station until the first train has departed. Alternatively, at two-platform stations with pedestrian crossings, a Train on Track 1 may be held in the station to block alighting passengers from crossing the tracks until the train on Track 2 has passed. In either case, overall running times for one or both trains are increased compared with times when there is no need to meet other trains.

As of Spring 2001, the Framingham / Worcester Line schedule had 21 inbound and 20 outbound commuter trains on weekdays. (The directional imbalance was a result of two equipment sets being coupled together in one outbound train before the start of the A.M. peak.) Boston arrivals scheduled between 7:00 and 9:30 A.M. included four inbound Framingham trains making all stops and five inbound Worcester trains making various combinations of stops. There were also three outbound Framingham trains making limited stops in the same time span. In the P.M. peak there were three departures to Framingham and four to Worcester between 4:00 and 6:15.

The line is also shared with a few Amtrak intercity trains from points west of Worcester. Amtrak schedules have historically varied more than commuter train schedules, but have generally included at least two trains per day in each direction.

Tentative plans for the commuter train schedule after full implementation of Worcester service include the same number of inbound and outbound A.M. peak trains as at present but with some changes in departure or arrival times. In the P.M. peak, it is expected that there will be eight or nine outbound trains compared with the present seven, but inbound frequency is not expected to change.

Trains on an I-290 extension would use the same tracks as Framingham and Worcester trains between Framingham and Boston. As discussed in Chapter 3, in order to provide running times competitive with driving, it would be necessary for all peak-period I-290 trains to run through to Boston, making either no stops or very limited stops between Framingham and Back Bay. All planned Framingham short-turn trains would be running in local service, so the I-290 extension could not be served simply by extending Framingham trains. Each I-290 train would therefore result in an increase in the total number of trains using the line.

In addition to the constraints of single track at Beacon Park and those of station layouts, the time slots available for operation of I-290 trains would be limited by the need to prevent local trains from being overtaken by express trains on the same tracks. A train running non-stop between Framingham and Back Bay would be as much as 19 minutes faster than a train stopping at all intermediate stations. To prevent a non-stop train from encountering any speed restrictions from a preceding local train on the same track it would be necessary for the express to depart Framingham by a minimum of about 25 minutes after the local. Possibilities for using both tracks for peak-direction service to allow express trains to pass preceding locals would be limited by schedules of reverse-commuting trains.

Ideally at stations served by both Worcester and I-290 express trains, schedules would be coordinated to provide uniform headways. It would not be possible to do this and also maintain adequate separation from local trains, however. Instead, I-290 and Worcester express trains would have to leave Framingham inbound only about five minutes apart. It is likely that express trains from both routes would serve Framingham but that West Natick and Natick would be served by either Worcester or I-290 trains but not both. With closely-spaced express trains, schedules would be arranged so that trains serving the fewest intermediate stops would leave Framingham or South Station first. Omitting Framingham as a stop on one of the two routes would reduce running time for that route slightly, but would prevent travel to Framingham from stations further west. It would also eliminate the possibility of transferring to local trains to travel to other stations further east, or of transferring between inbound Worcester trains and outbound I-290 trains.

As discussed in chapter 6, if all I-290 service were run through to Boston it would be likely to include at least six trips in each direction outside of peak hours. Because of relatively long intervals between trains, this should not pose a problem as far as other passenger trains are concerned. It could, however cause some problems in coordinating passenger and freight train operations east of Framingham.

Operational Issues at Framingham Station

At Framingham Station, as on most other segments, the Framingham / Worcester Line has two tracks, signaled for operation in either direction, with Track 1 being the more northerly of the two. From there to Framingham Centre, the existing tracks along the route of an I-290 extension are all included within the limits of the CSX Corp. North Framingham Yard. The distance between these endpoints is 2.1 miles, but multiple yard tracks are located only in the section from about 0.1 to 0.7 miles north of Framingham Station. Single tracks connect this yard area with Framingham / Worcester Line Track 1 in a full wye formation, allowing either eastbound or westbound trains to pass directly between Track 1 and the yard. The east leg of the wye enters Track 1 at the extreme east end of the Framingham Station complex, just west of the Concord Street grade crossing. The west leg of the wye enters Track 1 about 1,300 feet west of Concord Street.

There are no direct track connections between the yard and Track 2. Trains going eastbound from the yard can cross from Track 1 to Track 2 at CP-21, 0.1 miles east of the station. Likewise, trains going west bound from Track 2 to the yard must cross over to Track 1 at CP-21.

The historic Framingham Station building, now used as a restaurant, is on the south side of the tracks, centered about 200 feet west of Concord Street. The platforms there were limited to a length of about 340 feet, or four commuter rail cars coaches, by the street crossing on the east and the connection to the Holliston Secondary Track (former Milford Branch) on the west. A project still underway in September 2000 has replaced the old platforms with new 700-foot platforms west of the recently removed Holliston Secondary connection.

With the present track layout, passenger trains running between an I-290 extension and Boston in either direction would be unable to use either of the new main line platforms at Framingham Station. For these trains to stop at Framingham, it would be necessary either to construct a separate platform along the east leg of the wye north of the present station, or to construct a new connecting track with a junction to the west of the main line platforms. The latter option is not feasible, as there is insufficient land west of the new platform locations in which to build a track with a curve radius long enough for commuter rail cars. (Farm Pond limits the space available west of the present North Yard tracks.)

Another solution of having I-290 trains use the present west wye connection and reverse direction after entering the main line would add too much time because it would require making a brake test before proceeding, as well as increasing the distance traveled.

At present, the land on the east side of the east wye track is occupied by one of the main parking areas for Framingham Station. Installation of a platform there would require elimination of at least 50 parking spaces. Additional parking is being added on the

west side of the track. A platform located on that side could be connected with the new main line Track 1 platform by a walkway along the old platform location. The extension route platform would be on the outside of a curve, presenting a potential safety hazard, as engineers would be unable to see passengers boarding and alighting along the full length of a train. Some means would be needed to inform passengers which platform to wait on for the next train, since most inbound trains other than those from I-290 would continue to use the Track 2 platform.

Trains from an I-290 extension could also omit a Framingham Station stop entirely. This would prevent these trains from being used for local transportation between downtown Framingham and points on the extension, however. A stop at West Natick or some other station on the main line could be made to allow passengers to transfer to local trains serving other stations bypassed by I-290 trains.

Impacts at South Station

South Station would be the Boston terminal for I-290 extension trains until such time as a South Station-North Station rail connector was implemented. South Station currently has 13 tracks. The two most easterly tracks in the station, Tracks 12 and 13, are used almost exclusively by trains on the Old Colony Lines. This effectively leaves 11 tracks to be shared by all other commuter and intercity trains using the station. Track layout allows access to all station tracks from all entering routes, but not all platforms are suitable for all trains. Because of the irregular shape of the station, platform lengths are not uniform, and capacities range from 6 to 14 cars.

The number of tracks needed to serve all routes using South Station depends on the service frequency on each route and on the length of time that each train is in the station. All tracks end at the station, so all trains must reverse direction between arrival and departure. A train in the station may turn from an inbound to an outbound revenue trip, arrive from a yard and depart on a revenue trip, or arrive from a revenue trip and proceed to a yard. Regardless of which of these is the case, a train in the station usually occupies a track for a minimum of 10 minutes. Including time to enter and leave the station, a train effectively occupies a track for at least 15 minutes, resulting in a maximum capacity of four trains per track per hour. Schedules often call for trains to remain in the station longer than the 10-minute minimum because inbound arrivals times cannot all be matched that closely with scheduled departures. Trains going to a yard may have to wait in the station until yard space is clear or until a switching crew is available.

As of May 2000, schedules of South Side rail lines (including intercity service) called for 47 train arrivals in South Station between 6:30 and 9:30 A.M., including positioning of empty equipment sets from the Southampton Street yards. This was an average of 1.2 arrivals per hour per track. Throughout most of this span, the number of tracks occupied simultaneously did not exceed eight. There was, however, a brief time around 9:00 A.M. when all 13 tracks could have been occupied simultaneously. The exact

number would have depended on how rapidly empty train sets were moved out to yards.

Similarly, between 3:30 and 6:30 P.M. there were 45 scheduled departures including empty trains going to the yards. The number of tracks occupied simultaneously would seldom have exceeded eight, but 10 or more tracks would have been in use around 5:00.

The ability of South Station to accommodate I-290 extension trains would depend in part on how much service increased on the existing commuter and intercity lines or on new extensions other than I-290. Another area of uncertainty is the amount of storage yard capacity that will be available in the vicinity of South Station. Because of the phase-in of high-speed intercity train service from Boston to New York starting in 2000, the number of Amtrak-owned tracks in the Southampton Street yard available for use by commuter trains will be greatly reduced. This will require either that more trains be based at more distant yards, with associated increases in non-revenue mileage, or that more trains occupy tracks in South Station for prolonged intervals between trips.

With no changes from the May 2000 schedules other than planned increases in Worcester service, there would be open tracks at South Station at most of the times needed by I-290 extension trains. There could, however, be problems accommodating an arrival around 9:00 A.M. or a departure around 5:00 p.m.

Issues in Rolling Stock Scheduling

As discussed in chapter 5, because of limited yard capacity in Boston, rolling stock for an I-290 extension would most likely have to be based at a new layover facility at or near the outer terminal. To provide arrival times suitable for a range of work shifts at sites along the extension, reverse-commuting trips would have to leave South Station at approximately 6:10, 6:35, 7:10, and 7:45 A.M. With inbound service scheduled to meet likely demand patterns within constraints placed by schedules of Worcester express and Framingham local trains, scheduled arrivals in Boston from I-290 would be at about 7:15, 7:50, 8:25, and 9:00. The equipment from the 7:15 inbound arrival could be used on the 7:45 outbound trip. Positioning of equipment for the three earlier outbound trips would require operation of more early-morning inbound trains than would be justified by demand alone. (Under present schedules, equipment would not be available to turn from any of the other South Side lines to cover these trips.)

Equipment for a 6:10 A.M. outbound trip would need to be in South Station no later than 6:00 A.M. At present, the earliest scheduled South Station arrival time on any South Side line is 6:19 A.M. (The earliest North Station arrival on any North Side line is 6:20.) On each MBTA commuter rail route that currently has a train arriving in Boston before 6:30 A.M., ridership is much lower on that train than on any other arriving on the same route before 9:00 A.M. In the written comments section of the 1993 commuter rail survey (which obtained responses from 45% of all MBTA commuter rail users) fewer than 20 passengers from most routes requested earlier morning service than was then provided. The earliest arrivals then were no earlier than the present ones. Similarly,

the written comments on the 1998 Old Colony survey included only eight requests for morning arrivals earlier than 6:30. All of this suggests that a train arriving in Boston at 6:00 or earlier from an I-290 extension would carry few riders.

A 6:35 reverse-commuting departure would have to turn from equipment arriving in South Station no later than 6:25. At present the earliest scheduled South Station arrival on the Framingham / Worcester Line is 7:02 A.M. This is the latest initial arrival time of any South Side route. An I-290 train arriving in Boston around 6:25 could make local stops between Framingham and Boston to improve service on the main line.

A 7:10 reverse-commuting departure would have to turn from equipment arriving in South Station no later than 7:00. The equipment from the 7:02 Framingham local is already needed to cover a departure on another line. Schedules of other trains between Boston and Framingham would not leave an available time slot between 6:30 and 7:00 sufficiently far from the time of another train to be useful. Therefore, equipment for a 7:10 outbound departure would most likely be brought in coupled to the train used for the 6:25 arrival / 6:35 departure.

Of the outbound trips, the first two departures would arrive at I-290 in time for the equipment to turn to provide the last two inbound A.M. peak trips. Overall, with four A.M. peak trips in each direction, five train sets would be needed. Three of these would complete one trip in each direction, one would make only an inbound trip, and one would make only an outbound trip. Reducing the rolling stock requirement to four trains would necessitate eliminating either the 7:10 outbound trip, leaving a gap of about 65 minutes in outbound arrival times on the extension, or eliminating the 7:50 inbound arrival, leaving a 70-minute gap during the time of probable heaviest demand. Dropping both of these trips would reduce the rolling stock requirement to three sets. Based on travel patterns on existing lines and on distributions of work starting times, trips at these times would be the most heavily patronized ones in their respective directions, however.

In the P.M. peak, the planned schedules of Worcester express and Framingham local trains would limit the available departure times from South Station for I-290 trains to about 4:05, 4:45, 5:05, and 6:05. Inbound trains departing I-290 at times convenient for returning home from work locations along the extension would arrive at South Station at about 4:50, 5:25, 6:00 and 6:25. The equipment from the first two of these would be able to turn to provide the last two outbound P.M. peak trips, but the other two sets would arrive too late to turn to P.M. peak service. Of the four outbound P.M. peak trips, the first would arrive at I-290 in time for the equipment to turn to provide the last inbound reverse-commuting trip, but the other three would all arrive too late to provide any more P.M. peak service. Therefore, with four P.M. peak trips in each direction, it would be necessary to use five train sets, as in the A.M. peak. Three sets would each make one trip in each direction, one would make only an outbound trip, and one would make only an inbound trip.

If only four train sets were provided for I-290 service in each peak period, it would be necessary to eliminate either one outbound trip or one inbound trip in the P.M. peak. The trips dropped would have to be either the 6:00 inbound arrival or the 4:45 outbound departure, either of which would leave a service gap of about 60 minutes. Dropping both of these trips would allow service to be provided with only three equipment sets. A 4:45 departure would be expected to carry more riders than a 4:05 departure, and a 6:05 arrival would be one of the two most heavily patronized reverse-commuting trips, however.

APPENDIX E - ANALYSIS OF ALTERNATE STATION LOCATIONS

Role of Walk-In Potential in Station Site Selection

In the 1993 commuter rail survey, among passengers who reported walking as their mode of access to the outer boarding station, 96% reported access times of 20 minutes or less. In the Old Colony survey the corresponding figure was 93%. At typical walking speeds, this would mean that most walk-ins had access distances of under one mile. As will be seen from the discussion below, the number of potential users of an I-290 commuter rail extension who would live within one mile of a station would be relatively small. Residents of homes within a one mile radius of a station who could use commuter rail to make their usual trips would not all choose to do so, and not all of those that did would walk to the station. Therefore, in planning stations for the extension, highway access and parking availability would be of greater importance than walk-in potential. Trip origins would be too widely scattered to allow for cost-effective feeder services.

As discussed in Chapter 4, home-to-work trips ending in either Boston or Cambridge accounted for 87% of the inbound weekday ridership on the commuter rail lines that terminated at South Station in 1993, and for 78% of that on the Old Colony lines in 1998. Work trips to Boston Proper alone accounted for the largest share of these trips. It is reasonable to assume that Boston and Cambridge work trips would also be the primary market for an I-290 commuter rail extension. Journey-to -Work figures from the 1990 Census show that only 1% of the residents of Northborough, or Marlborough worked in Boston Proper. For Framingham, the figure was 3.2%, and for Southborough it was 2.4%. Of these four municipalities only Framingham (6.9%) and Southborough (5.5%) had over 5% of their residents employed in all of Boston or Cambridge. Southborough also had the lowest population total of the four, however.

Northborough Population Distribution

In the 1990 Census figures, 257 Northborough residents worked in Boston or Cambridge. With uniform distribution of origins, this would have averaged about 14 per square mile. A circle with a radius of one mile centered on a rail station, representing the walk-in attraction area, would have a total area slightly over three square miles. Therefore, such a circle drawn in Northborough would have enclosed the homes of an average of about 45 Boston or Cambridge workers in 1990.

Actual population density is slightly higher than the town-wide average in the area surrounding the old Northborough Center station site, but the number of Boston and Cambridge workers living within one mile of the station probably did not exceed 90. Not all of these would use commuter rail if a station were re-established at the old site, and not all of those who would use such a station would walk to it. No other location along the rail line would be within walking distance of a larger number of homes.

Northborough is outside of the MAPC Region but is within the Eastern Mass. Regional Planning Project (EMRPP) area, so it is included in MAPC population forecasts for future years. The latest forecast indicates that in the year 2020, the population of Northborough will be 31.4% greater than it was in 1990. U.S. Census figures show that about half of the projected growth from 1990 to 2020 had already occurred by 2000. The pace of future growth will be slowed as land available for development becomes more scarce.

Growth in Northborough is likely to be concentrated in areas more than one mile from the center, where land is now less developed. With present trends in lot size, however, density would remain lower than that around the town center. The 1990 Census figures showed that 2.2% of Northborough residents were then employed in Boston or Cambridge. As housing prices encourage Boston commuters to move to more distant suburbs in the future, this proportion is likely to increase.

Based on the patterns in communities with well-established commuter rail service at distances from Boston similar to that of Northborough, the highest the proportion of town residents working in Boston or Cambridge would be likely to reach by 2020 would be around 4%. Applying this to the maximum population projection would result in an estimated 625 Boston or Cambridge workers in the town, or a gain of 144% compared with 1990. With uniform distribution, a circle with a one-mile radius would include homes of about 110 such workers. Growth in Boston and Cambridge workers around the town center would occur more from turnover than from new construction, so the total there would probably not exceed 200 within a one-mile radius. Boston and Cambridge workers living within one mile of a station would not all use commuter rail, and not all of those that did would walk to the station. The absolute number of potential walk-in riders would differ too little in different sections of town to be a deciding factor in station site selection.

A station at the Colburn Street site would be closer to more work locations than any other site in Northborough. Nevertheless, the distance from this site to any major employment area would be greater than the distance that most commuters would be willing to walk. Therefore, regardless of the station location, connecting shuttle bus or van service would have to be provided to attract significant numbers of reverse commuters.

Marlborough Population Distribution

In the 1990 Census figures, 893 Marlborough residents worked in Boston or Cambridge. With uniform distribution of origins, this would have averaged about 41 per square mile. On average, a one-mile radius circle would have enclosed homes of about 125 of these workers. Possible choices for a station site within the city are very limited, because the rail line enters it for only two short stretches along the south border. In one of these, existing and anticipated land use is entirely non-residential. In the other, population density is far below the city-wide average. Therefore, no station site within

Marlborough would have been within walking distance of the homes of as many as 125 Boston or Cambridge workers at 1990 levels.

Marlborough is already much more built up than Northborough, and has most recently been projected to have a population increase of 26.7% between 1990 and 2020. Most of the land suitable for new residential development is more than one mile from the railroad line. The 1990 Census figures showed that 2.8% of Marlborough residents were then employed in Boston or Cambridge. Based on the patterns in communities with well-established commuter rail service at distances from Boston similar to that of Marlborough, this proportion would be likely to increase to at most around 4% with an I-290 extension. Applying this to the projected population in 2020 would result in an estimated 1,610 Boston or Cambridge workers in the town, or a gain of 81% compared with 1990. This would raise the average number of such workers living within a one-mile circle to 230, but the number within this distance of any potential station site would be much lower than that. Boston and Cambridge workers living within one mile of a station would not all use commuter rail, and not all of those that did would walk to the station. Therefore, residential walk-in potential would not be a major deciding factor in site selection for a Marlborough station.

A station in the vicinity of D'Angelo Drive could serve reverse-commuting trips to offices and industries along I-495, but most of these are further from any potential station than the distance that most commuters would be willing to walk. Furthermore, none of the roads from the station to these employment areas have sidewalks. Therefore, regardless of the station location, connecting shuttle bus or van service would have to be provided to attract significant numbers of reverse commuters.

Framingham Population Distribution

In the 1990 Census figures, 4,499 Framingham residents worked in Boston or Cambridge. With uniform distribution of origins, this would have averaged about 176 per square mile. On average, a one-mile radius circle would have enclosed homes of about 550 of these workers. The overall population of the town is projected to increase by only 4.1% between 1990 and 2020, as there is relatively little remaining land suitable for residential development. Recent trends also indicate little growth in the proportion of Framingham residents working in Boston or Cambridge. At most, it would be expected to increase from the 6.9% reported in 1990 to around 8.0%. Applying this to the projected population in 2020 would result in an estimated 5,410 Boston or Cambridge workers in the town, or a gain of 20% compared with 1990. This would raise the average number of such workers living within a one-mile circle to 665.

Boston and Cambridge workers living within one mile of a station would not all use commuter rail, and not all of those that did would walk to the station. The 1993 commuter rail survey showed only 130 walk-ins to Framingham Station for all trip purposes all day, even though the number of Boston and Cambridge workers living within one mile of the station at that time would have exceeded 550.

Between Framingham Station and Framingham Centre the route of an I-290 extension is bordered on the east by an area with greater than average population density, but much of the line is separated from this area by the railroad freight yards. To the west, much of this segment is separated from populated areas by Farm Pond. In any case, this segment is too close to Framingham Station to justify another station.

Of all of the assumed station sites on an I-290 extension, a Salem End Road / Framingham Centre station would have the greatest potential for attracting walk-in traffic. Within the one-mile radius of this site there are some sectors with population density exceeding the townwide average, but many with lower density. Future residential development in many of the latter sectors will be limited because of present uses including reservoirs, cemeteries, businesses, and schools.

The proximity of this site to Framingham State College would make it convenient for students commuting from other points served by the line if train arrivals and departure times were well coordinated with class starting and ending times. The college market alone would not be large enough to dictate train schedules, however. As discussed elsewhere in this study, specific times at which trains could be run on the extension would be severely constrained by the need to share the line between Framingham and Boston with other trains, and by the amount of single track on the extension itself.

Between Framingham Centre and the Southborough town line, the extension route traverses areas with population density lower than that of Framingham as a whole. The western half of this segment is bordered by the Framingham Technology Center, Mass. Turnpike Interchange 12, and an MWRA reservoir. Much of the rest is blocked by the Turnpike from any possible walking access from residential areas.

The Technology Center could be a destination for work trips either from stations further out on the extension or stations closer to Boston, but it is not well suited for pedestrian access. None of the interior roads have sidewalks, so pedestrians must walk either across lawns and parking lots or along the edges of narrow roads used by many large delivery trucks. Walking would be particularly hazardous in bad weather. The overall complex is fairly compact, but the walking distance from the rail line at California Avenue to many of the larger employment sites would exceed the distance that most commuters would be willing to walk even with sidewalks. Access to several of the buildings requires climbing a steep hill known as The Mountain. Pedestrian access to work locations south of the Technology Center would also be impractical because of distance and heavy traffic on intervening roads. Therefore, regardless of the station location, connecting shuttle bus or van service would have to be provided to attract significant numbers of reverse commuters.

Southborough Population Distribution

Although an I-290 extension would run through Southborough, the present study assumes that it would not have a station in that town. In the 1990 Census figures, 364 Southborough residents worked in Boston or Cambridge. With uniform distribution of

origins, this would have averaged about 24 per square mile. On average, a one-mile radius circle would have enclosed homes of about 74 of these workers.

Southborough has one of the highest projected population growth rates from 1990 to 2020 of any town or city in the I-290 extension service area, at 53.6%. (About half of the projected growth had already occurred by 2000.) In the 1990 Census figures the number of Southborough residents employed in Boston or Cambridge equaled 5.5% of the total town population. Based on the distance from Boston and the competition from nearby employment opportunities along I-495 or in Framingham, the proportion of Southborough residents working in Boston or Cambridge is likely to grow to at most about 7.5%. Applying this to the projected population in 2020 would result in an estimated 765 Boston or Cambridge workers in the town, or a gain of 110% compared with 1990. This would raise the average number of such workers living within a one-mile circle to 155. Boston and Cambridge workers living within one mile of a station would not all use commuter rail, and not all of those that did would walk to the station.

The area around Southborough Center, where the 1990 study and the PMT assumed there would be a station, has population density only slightly greater than that of the town as a whole. Possibilities for new development within one mile east of the rail line between Southborough Center and the first crossing of the line into Marlborough are limited by the location of the MWRA Sudbury Reservoir. On the north side of town where the extension route runs along the border of Marlborough, much of the open area along the right-of-way is wetlands, and much of the rest is within a mile of the proposed D'Angelo Drive Station site. There are no major employment areas within walking distance of any point on the line within the town. For these reasons, no station site in Southborough would have significant walk-in traffic potential.

General Characteristics of Past Stations on I-290 Extension Route

Passenger service was last operated in 1937 on the south half of the rail line that would be used for an I-290 extension, and in 1931 on the north half. These are much earlier dates than those of service discontinuances on most lines that have been studied recently for possible service restoration. Hence, the characteristics of the towns that an I-290 extension would run through would be expected to have undergone much greater changes since they last had direct rail passenger service.

None of the past station sites on the I-290 extension route between Framingham Station and I-290 have any remains of platforms, lighting, or parking facilities that would be suitable for future rail passenger service, so construction costs would be similar at these sites or at entirely new ones. Most of the past stations were located when the rail line was constructed in the mid-1800s. Access then would have consisted mainly of walk-ins with some drop-offs by horse and carriage, so there was no reason to provide for all-day vehicle parking. Traffic levels on the line never grew sufficiently to call for major station modernization. Off-street parking at stations consisted at best of a few unpaved spaces.

Locations of Past I-290 Extension Route Stations

Historically, when passenger service was operated on the Fitchburg Secondary Track there were two stations each in Framingham, Southborough and Northborough, and one in Marlborough. (A second Marlborough station was at the end of a 1.4-mile branch off the Fitchburg Secondary.) The official railroad directions of the Fitchburg Secondary Track are north toward Fitchburg and south toward Framingham, but the actual compass directions vary from these in many places. For purposes of discussing station locations below, compass directions are used.

Past Sites in Framingham

After leaving the Framingham / Worcester line at Framingham Station the first station was Montwait, on the north side of Mount Wayte Avenue in Framingham. Service to this station ended in the 1920s. By present-day standards, a station at this location would be too close to Framingham Station, at only 1.2 miles, unless it served an unusually large trip generator, or had good access from a major highway. Neither of these conditions applies. Montwait Station replaced an earlier station called Lakeview that was located closer to the south bank of the Sudbury River. That station served a small cluster of summer cottages.

The next station north was Framingham Centre, located between Salem End Road and Route 9. This is close to the location assumed for a future Salem End Road / Framingham Centre station. The preliminary plan for such a station in the 1990 feasibility study shows it as being just south of Salem End Road, in order to provide adequate parking capacity. An existing 250-car surface parking lot for Framingham State College would be replaced by a three-level joint-use facility under the 1990 plan. This station would also serve walk-in traffic from the college and nearby residential areas.

Past Sites in Southborough

The first of the two stations in Southborough was Fayville, on the east side of Central Street, which the railroad crosses at grade. Development along Central Street is predominantly residential, but the street is also used as a cross-connection between Route 9 and Route 30. Fay Memorial Park, a town recreation area, occupies the west side of Central Street south of the railroad crossing, and is itself bounded to the west by the MWRA Sudbury Reservoir. Walk-in traffic potential alone would be insufficient to support a station at this location, but a major parking lot would be inconsistent with adjoining land use. The rail distance from this site to the proposed California Avenue / Route 9 & 90 station site is only 1.2 miles.

Southboro Station, the only other one within the town, was on the south side of Main street near the town center. The 1990 study assumed that there would also be a station at this site on a new extension, but it would include a 250-car surface parking lot which the old station did not have. Most of the area that would have been used for parking

under this plan is vacant, but some parking for existing businesses would be lost. In the 1990 study, service on the Fitchburg Secondary was assumed to be run as an alternative to, rather than along with, the Worcester extension. The latter project, which is in the process of implementation, will include a station in Southborough about 2.5 miles from the center. That station will include a 400-car parking lot.

Past Site in Marlborough and Site Proposed in 1990 Study

Only two short segments of the Fitchburg Secondary Track are located within Marlborough. In the past, the only station was on the first of these segments from Framingham. This was Marlboro Junction Station, which was just north of the border of Southboro, accessed by a private road running west from Mill Street. Present land use in the immediate vicinity of this site is mostly industrial, but there is some low-density residential development within a short distance. The south side of the track at the former station site is now bounded by the Marlborough Equestrian Center, which includes stables and a half-mile riding ring around a grazing pasture. To obtain sufficient land for parking without displacing existing development, it would be necessary to relocate the station slightly further west than the former site.

Access from downtown Marlborough to a relocated Marlboro Junction station via Route 85 (6 minutes) would be slightly faster than to the D'Angelo Drive station site (9.5 minutes). On-board train time from Marlboro Junction to Framingham would be about three minutes less than the time calculated from D'Angelo Drive with no stop at Marlboro Junction. If trains stopped at both locations, times from D'Angelo Drive and I-290 would increase by about two minutes from those shown in table 3-1.

A Marlboro Junction station would have faster access than D'Angelo Drive from Hudson as well as from Marlborough, but would be less convenient for trips starting in Berlin, Bolton, Clinton, or Lancaster. Traffic going to Marlboro Junction would result in some increase in congestion on two-lane Route 85. Most of the traffic going to D'Angelo Drive would either use I-495 anyway, or would be diverted to I-495 from more congested local roads.

The 1990 feasibility study assumed that a station serving Marlborough would be located at a new site on Northborough Road, just west of I-495. It would actually have been in Southborough, but near the point where the rail line crosses into Marlborough for the second time. It was to be the outermost station on the extension, with surface parking for 1,000 cars. This site is about one half mile east of D'Angelo Drive and two miles west of the former Marlboro Junction site. It was envisioned primarily as a park-and-ride facility as it would have been within walking distance of very few homes. It would also have been further than D'Angelo Drive from any employment areas.

The study concluded that such a station would be very costly to construct. Although no taking of buildings would be needed, a large electric utility transformer yard would have to be relocated, and part of Northborough Road would have to be re-aligned. Heavy grading would be required to make the site level enough for parking. Although

the site is close to I-495, there is no direct access to it from that highway. The study assumed that a new interchange would be built at Northborough Road. Such an interchange would now be too close to the recently opened Industrial Park Road interchange but the latter does not have a direct connection to Northborough Road. Instead, it would be necessary to drive directly past the D'Angelo Drive site to get to the Northborough Road station from I-495. Most traffic going to a Northborough Road station from either inside or outside Marlborough would be likely to follow this path. Given present land use and recent highway access improvements, a D'Angelo Drive station would be preferable to a Northborough Road station.

Past Sites in Northborough

The first of the two stations in Northborough was originally called Hospital and later called Talbot. It was located a short distance east of the Lyman Street bridge over the railroad, with access off Talbot Road. The immediate area around this site has had some recent industrial development, including a large warehouse and distribution center that uses rail freight service. Most residential development is at least one half mile from the site, and is of low density. Lyman Street is not designed for high traffic volumes, but can be used as part of a cross-connection between Route 20 in Northborough and Route 9 in Westborough. This site would not have convenient access from any limited-access highways, reducing its likely market area to small sections of Northborough or Westborough.

Northborough Station, the only other one within the town, was located between the East Main Street (Route 20) and Pierce Street grade crossings in the town center. This would be the most centrally located site for a station in the town, but as it is in the most built-up area there is little land around it that could be used for parking. Route 20 and Route 85 both provide access to this site from the south, but would draw traffic from the same base as the new Westborough Station on the Framingham / Worcester Line. Route 20 would also provide a link to the station from I-495 to the east, but it would be much longer than the connection to an I-290 station. As discussed elsewhere in this study, traffic going to an I-290 extension from I-495 is more likely to flow to a D'Angelo Drive I-495 station than to a Northborough / I-290 station because of small differences in access times but shorter on-train times and lower fares at D'Angelo Drive. The same factors would work against a Northborough Center site in attracting traffic from I-495.

The next station north of Northboro Station in the past was in Berlin, about two miles beyond the point where an I-290 extension would end. A possible further extension on that segment is discussed in appendix G.

APPENDIX F - ANALYSIS OF DEMAND POTENTIAL FOR REGIONAL PARK-AND-RIDE STATIONS

Introduction

At a June 30, 1999 meeting with members of the Marlborough Transportation Task Force, some preliminary findings from the CTPS I-290/Northborough Commuter Rail Extension Feasibility Study were discussed. These included a list of the cities and towns that would be served directly or indirectly by the extension. Some of the meeting participants felt that the size of the service area was understated, particularly with respect to the station located near the interchange of the Mass. Turnpike (I-90) and Route 9 in Framingham. The Task Force envisioned this as being a major regional park-and-ride facility.

Because of this concern, the potential market area for a Route 9 & 90 station was re-examined at a finer level of detail. The results are contained in this appendix. The overall conclusion is that although a Route 9 & 90 station would appear at first to have a large traffic potential, a thorough analysis of potential sources of ridership shows that it would be used mostly by residents of Southborough. It would attract some riders from other towns, but the number from most other individual towns would be too small to predict. Therefore, an add-on factor to Southborough origins would be the most appropriate way to calculate total use of this station.

Summary of Analysis Method

The first step in re-examining the market area of a Route 9 & 90 station was to look at the attraction areas of existing MBTA commuter rail stations located near interchanges of major highways and having either high parking capacity or capacity exceeding demand.

The 1993 commuter rail survey found that at almost all stations at least two thirds of the riders had trip origins either within the same city or town as the station or within a city or town bordering directly on the one with the station. At many stations, this proportion was much higher than two thirds. The only stations with much larger attraction areas were either designed as regional park-and-ride facilities or were the outermost stations on their routes. The 1995 Worcester Station commuter rail survey and the 1998 Old Colony Lines survey found patterns similar to these.

A detailed discussion of nine existing MBTA regional commuter rail park-and ride stations appears at the end of this appendix. At these stations, most of the origin towns beyond those adjoining the station town shared certain characteristics in survey results. Among these were:

• There was a continuous limited-access highway route to the station either from the origin city or town itself or from a nearby interchange in an adjoining city or town.

• The limited-access route described above was a sub-segment of a commonly used driving route between the origin city or town and Boston (excluding the final link from a highway interchange to the station.)

• The origin city or town either had no direct commuter rail service or had service that was less frequent or much slower than that available at the park-and-ride station.

• The origin city or town had a much larger number of residents making work trips to Boston or Cambridge in the 1990 Census Journey-to-Work tabulations than the number captured by commuter rail in the surveys.

• The driving time from point of origin to boarding station via a direct route under average traffic conditions did not exceed 50 minutes. (Reasons for this 50-minute limit are discussed below.)

Despite drawing riders from larger-than-average service areas, each of the nine stations examined attracted 90% of its riders from only 30% to 50% of all of the cities and towns reported as trip origins of passengers using that station.

A Route 9 & 90 station would be located only a short distance from the most heavily used highway route into Boston from the west, but would otherwise lack many important characteristics of a major park-and-ride facility. It would not be the outermost station on its route, so some riders who might otherwise use it would be intercepted at the stations in Marlborough or Northborough. Other riders would find more convenient access and similar total travel time by using one of the stations on the Worcester Line rather than a Route 9 & 90 station or any other on an I-290 extension. Many towns from which there would be convenient highway access to a Route 9 & 90 station and that would not be served directly by any other commuter rail line have never generated large numbers of work trips to Boston or Cambridge, and are not expected to do so in the near future.

Further Discussion of 50-minute limit on Driving Access to Commuter Rail Stations

Maximum Driving Times To Present Stations

In survey results from users of present MBTA commuter rail regional park-and-ride stations, one of the common findings is that few, if any, passengers report driving times of more than 50 minutes to the boarding station. Of the nine stations discussed at the end of this appendix, three (Dedham Corporate Center, Mishawum, and Middleborough/Lakeville) had no survey responses from passengers with park-and-ride or drop-off access trips of over 50 minutes. Three others (Lowell, Forge Park, and South Attleboro) each had three or four responses from passengers reporting park-and-ride or drop-off access trips of 55 to 70 minutes. All of these were found to exceed the averages reported by other passengers going to the same stations from the same towns by at least 30 minutes. They also exceeded times reported from more distant origins. It was concluded that in these cases, times over 50 minutes were either wrong answers or

were for access trips that included intermediate stops. Such responses do not alter the conclusion that these three stations did not attract passengers from origins from which usual access times would exceed 50 minutes.

At Route 128 Station survey responses included two reported access trips of 55 minutes, one of 60 minutes, and one of 70 minutes, but no other responses exceeding 50 minutes. With the sample rate obtained at this station, responses above 50 minutes represented 1.4% of the total station users at the time, or 17 riders. The 60-minute trip could not be checked for reasonableness, as no origin was shown. The 55-minute times were from Fall River and Bourne and the 70-minute trip was from Falmouth. These looked reasonable, although there were two other responses showing 40 to 45 minute access times from Fall River.

The 1993 survey preceded the implementation of Old Colony service. At the time, the only commuter rail station that residents of Fall River, Bourne, or Falmouth could have used with a shorter diversion from the most direct highway route to Boston was Stoughton. No Bourne or Falmouth residents reported going to any station other than Route 128, but there were three surveys (representing six riders) for trips from Fall River boarding at Stoughton. The trips from Bourne and Falmouth via Route 128 were equal to only 1.3% of total work trips to Boston or Cambridge from these towns. The trips from Fall River via Route 128 (with average access time below 50 minutes) were equal to 4.3% of the Boston and Cambridge work trips from there.

At Worcester Station the 1995 survey had only one response with an access time exceeding 50 minutes. This was for a trip from Springfield, with a reported time of 60 minutes. This survey had a response rate of close to 100%, so the responses do not represent more than one passenger each. Two other Worcester boardings were reported from Springfield with access times below 50 minutes. The three trips combined were equal to 3.8% of total work trips to Boston or Cambridge from Springfield.

At Kingston Station, the Old Colony survey had only three responses with driving access times exceeding 50 minutes, including one at 55 minutes and two at 60 minutes. All three were from origins on Cape Cod, and only one, at 60 minutes, was for a repetitive home-to-work trip. The maximum access time for a drop-off passenger was 45 minutes.

The results above show that the existing commuter rail system attracts almost no riders from points where normal auto-access times to boarding stations would exceed 50 minutes. This is only partly because the number of potential users who would have to travel more than 50 minutes to a station is small. In addition, the commuter rail share of all work trips to Boston and Cambridge from cities or towns over 50 minutes from the nearest station is small, and in many cases non-existent.

Reasons for Observed Maximum

Passenger survey results cannot show definitely why many people who could use commuter rail choose other alternatives. Nevertheless, the characteristics of passengers and their trips lead to some reasonable conclusions about non-riders. Because of relatively long headways, most commuter rail riders plan to arrive at their boarding stations to catch specific trips rather than arriving without regard to the schedule and waiting for the next train. Survey results show that most passengers try to time their station arrivals to minimize waiting time but also to allow a margin of error for traffic delays on the way to the station. At the nine stations discussed at the end of this appendix, the average reported waiting times for park-and-ride passengers ranged from 3.8 to 8.8 minutes. The proportion of passengers waiting five minutes or less to board ranged from 51% to 80%. The proportion waiting less than 10 minutes ranged from 79% to 98%.

The greater the length of the access trip to a station is, the greater the chances are of unforeseen delays occurring along the way. Therefore, passengers with the longest access trips must allow the greatest margins of error when determining how far ahead of train departure times they should leave their actual starting points. The survey results suggest that most people who would have to drive for more than 50 minutes to reach a station perceive the required margin of error in the access trip as being so great that it is not worthwhile to even attempt to use commuter rail.

Another contributing factor in the 50-minute upper-bound on station access is that commuter rail times to Boston from most stations are longer than driving times. Passengers who would have to drive for more than 50 minutes just to reach a commuter rail station already have long total travel times to Boston. Apparently most of them are unwilling to make their long trips even longer by using commuter rail for part of the way.

Analysis of Route 9 & 90 Station Market Area by Approach Path

A Route 9 & 90 station would be located near the grade crossing of the I-290 extension with California Avenue, which is one of two access roads into the Framingham Technology Park. (The other access road is New York Avenue.) This site is near the western border of Framingham, and would be less convenient than other stations for most Framingham residents. Therefore, most of the riders using it would come from other towns.

There is no direct highway access to this site from towns north or south of Framingham and towns further east have better access to other stations, so traffic from outside of Framingham would approach from the west. The two main approach paths would be Route 9 and the Mass. Turnpike (Route I-90). Some additional traffic would approach via Route 30 and New York Avenue.

Towns Connected with Route 9 & 90 Station via Route 9 or Route 30

Direct Connections via Route 9

On Route 9, the next town west of Framingham is Southborough, which has already been assumed to be in the service area of the extension. The Route 9 & 90 station would be the most convenient one on the extension for Southborough residents unless the extension included a station directly in that town. The Southborough market would be split between a Route 9 & 90 station and the Southborough station about to be built on the Framingham / Worcester Line.

The next town west of Southborough on Route 9 is Westborough. A station on the Framingham / Worcester Line in that town is about to be built. The station will be west of the town center, but population density is also highest on that side of the town. Extensive wetlands limit possibilities for future development of the east side. From almost all origins in Westborough access time to the new Westborough station would be less than access time to a Route 9 & 90 station via Route 9, but for many of these trips access to the Westborough station would require some doubling back. The estimated train running time to the present Framingham Station would be shorter from Route 9 & 90 than from Westborough Station (9 minutes versus 15). If Worcester trains continued serving West Natick and Natick but I-290 trains made no local stops on the main line, this would give a further time saving of about five minutes from Route 9 & 90.

At best, a Route 9 & 90 station would offer lower combined access and line-haul time than Westborough Station from as far west on Route 9 as Route 135. Commuter rail users entering Westborough on Route 9 from towns further out would minimize travel times by diverging onto Otis Street to the Westborough station rather than continuing on Route 9 to a Route 9 & 90 station.

Direct Connections via Route 30

State Route 30 has several indirect connections with Route 9 in Southborough and also has a direct link into the Framingham Technology Park via New York Avenue. It could be used by some traffic going to a Route 9 & 90 station. Route 30 is north of Route 9 in Southborough, but crosses to the south in Westborough. Traffic from points west of that crossing going to a Route 9 & 90 station would be likely to proceed on Route 9 rather than on the more circuitous Route 30. As discussed above, the fastest service on an I-290 extension would result in faster overall travel times to Boston than those via Westborough Station from points on Route 9 as far west as Route 135. Similarly, such service would result in the fastest overall travel times from points on Route 30 as far west as Route 135 at Westborough Center. Based on population distribution and suitability of land for future development, a Route 9 & 90 station would be likely to capture at most 25% of the commuter rail traffic from Westborough. Most of these riders would be diverted from Westborough Station.

The next and final town on Route 30 west of Westborough is Grafton. Another new station on the Framingham / Worcester Line in Grafton adjacent to Route 30 a short distance west of the Westborough border opened in February 2000. This station is likely to intercept most rail users from the Route 30 corridor in Grafton before they even get to Westborough. Any Grafton riders who did follow Route 30 in to Westborough would be more likely to go to Westborough Station than to Route 9 & 90, in order to minimize their travel times.

Indirect Connections via Route 9 or Route 30

State Route 85 connects with both Route 9 and Route 30 in Southborough and could be used as part of an access route to a Route 9 & 90 station. A station on the Framingham / Worcester Line is about to be built on Route 85 on the southern border of the town. Any rail users entering Southborough on Route 85 from towns further south would have to go directly past this station and would be unlikely to continue on to a Route 9 & 90 station. On the north side of Southborough, Route 85 goes through Marlborough and Hudson and ends in Bolton. All three have already been included in the extension service area. Because of road layout, I-290 extension riders from Hudson and Bolton would be most likely to use the D'Angelo Drive station in Marlborough, but some riders starting from Marlborough would find Route 9 & 90 more convenient.

State Route 135 connects with both Route 9 and Route 30 in Westborough and could theoretically be used as part of an access route to a Route 9 & 90 station. As discussed in the preceding subsections, the intersections of Route 135 with Route 9 and Route 30 would be the westernmost points from which total travel time to Boston could be faster via Route 9 & 90 than via the new Westborough Station. Riders starting from points along Route 135 within Westborough would be most likely to go to the Westborough station.

The next and last town on Route 135 north of Westborough is Northborough, which is already included in the I-290 extension service area. Some Northborough riders would prefer a Westborough station to any I-290 extension station, but it is unlikely that any Northborough riders would go to Route 9 & 90 by driving through Westborough.

The next town on Route 135 south of Westborough is Hopkinton. Use of Route 135 to access Route 9 eastbound from Hopkinton would involve excessive doubling back compared with other alternatives.

In conclusion, most riders approaching a station at Route 9 & 90 from the west via either Route 9 or Route 30 would have trip origins in either Southborough, Westborough, or Marlborough.

Towns Connected with Route 9 & 90 Station via Mass. Turnpike

The average distance between interchanges is much longer on the Mass. Turnpike than on most other limited-access highways in eastern Massachusetts. This places a

constraint on the number of cities and towns from which the Turnpike could be used conveniently to access a Route 9 & 90 station. The first sub-section below describes the access route between the Turnpike and a Route 9 and 90 station. The later subsections analyze traffic potential by origins.

Access Path From Turnpike to Route 9 & 90 Station

With present highway layouts, traffic going to a Route 9 & 90 station via the Mass. Turnpike would exit at Interchange 12 in Framingham, which is east of California Avenue. After passing through the toll booths, station traffic would take the ramp to Route 9 westbound, which it would follow to California Avenue. The total distance from the start of the Mass. Pike exit to the station would be 1.5 miles. Allowing for delays at the toll booths and congestion on Route 9, and for time to park at the station and deposit the parking fee, the total time for a passenger from exiting the Pike to arrival on the station platform at a Route 9 & 90 station in peak hours be at least 5 minutes.

Until recently, California Avenue connected with only the westbound side of Route 9. Traffic entering the Framingham Technology Park from the west used New York Avenue from Route 30 in Southborough. Conversely, traffic going from the Technology Park to Route 9 eastbound had to start out via New York Avenue and Route 30. In 1999 the intersection of California Avenue and Route 9 was reconstructed to provide a direct connection with Route 9 eastbound, however. This was done to make California Avenue the primary entry point to the Technology Park from the west as well as from the east. It is expected to increase the maximum morning hourly traffic volume on California Avenue toward the station site from the 700 vehicles counted in 1994 to 1,855 in 2004. Traffic going to a station off California Avenue would be in addition to this.

With the new layout of the Route 9/California Avenue intersection, passengers returning from the station to the Mass. Pike would take Route 9 eastbound from California Avenue to the Interchange 12 on-ramp. The layout of Interchange 12 itself was originally dictated by the acute angle of the crossing of the Turnpike under Route 9, by the need to provide sufficient distance between the ends of ramps and the toll booths to avoid backups out onto either the turnpike or Route 9 during peak travel times, and by a standard practice of having a single set of toll booths serve all traffic entering or exiting in all directions for maximum operating efficiency. Any redesign of Interchange 12 to improve connections to California Avenue would still face these constraints as long as this segment of the Turnpike is to be operated as a toll road.

Avoiding property-taking was not a major consideration in the 1950s when Interchange 12 was built, as most of the surrounding land was then vacant and there was seldom organized opposition to highway construction. Therefore, it was possible to optimize design within the limits imposed by geographic barriers including hills and a reservoir. With present land use around Interchange 12, relocation of ramps for more direct connections to California Avenue would require taking of many commercial properties and some homes. The resulting travel time improvement for traffic going to a Route

9 & 90 station would be relatively small, while travel times for other traffic using the interchange would not be improved and might be made somewhat worse.

Given the problems cited above, it is unlikely that a major reconstruction of Interchange 12 would be undertaken in conjunction with a Route 9 & 90 commuter rail station. Therefore, for purposes of analysis it is assumed that station access would most closely resemble the present paths to the station site including the added connection with Route 9 eastbound.

Points Served by Mass. Turnpike East of Interchange 12

To the east of Interchange 12 (at Route 9 in Framingham) the next Turnpike entry point is Interchange 13 on the border of Framingham and Natick. The distance between these two interchanges is 5.4 miles. It would not be advantageous for riders going to Boston to take the Turnpike west from Interchange 13 (or any entry point further to the east) to board a train at Route 9 & 90 instead of boarding at a station closer to Boston on the Framingham / Worcester Line. Therefore, the Turnpike would be used to access a Route 9 & 90 station only from points further to the west.

Points Served by Interchange 11A North of Turnpike

The next entry point on the Turnpike west of Interchange 12 is Interchange 11A at Route I-495 in Hopkinton. The distance between these two interchanges is 5.2 miles. There is no access to the Turnpike from local streets at Interchange 11A, so it is necessary to travel on I-495 before entering the Turnpike there. To the north of Interchange 11A, the first access point to I-495 is at Route 9 in Westborough. From the intersection of I-495 and Route 9 the shortest path to a Route 9 & 90 station would be via Route 9 rather than via I-495 and the Mass. Turnpike. The saving in distance is sufficient to offset the lower average speed on Route 9. Therefore riders going from Westborough to a Route 9 & 90 station would be more likely to take Route 9 than the Turnpike. These riders have already been accounted for in the discussion of approaches via Route 9.

After Route 9, the next entry point to the north on I-495 was formerly Route 20 in Marlborough, but a new intermediate entrance at Industrial Park Road in Marlborough was recently opened. The new interchange would be the point where traffic from further north on I-495 would exit to go to a D'Angelo Drive station. Any traffic going to a Route 9 & 90 station from points on I-495 north of Route 9 would in effect be diverted from other extension stations. Origin towns of such traffic have already been included in the assumed extension service area.

Points Served by Interchange 11A South of Turnpike

Hopkinton
To the south of Turnpike Interchange 11A the first entry point to I-495 is at West Main Street in Hopkinton. This interchange is 1.3 miles west of the town center. For a trip

starting at the town center, the fastest access to a commuter rail station would be to take Route 85 north to the new Southborough station on the Framingham / Worcester Line. Based on travel time runs conducted by CTPS in 1998, the average time to drive to the Southborough station from the center of Hopkinton at Routes 85 and 135, including time to park and deposit the parking fee, would be about 5 minutes. This is consistent with times that would be expected on the basis of speed limits and land use along this section of Route 85.

Based on a combination of travel time observations and calculations from distances and traffic speeds, the access time from the center of Hopkinton to a Route 9 & 90 station via I-495 and the Mass. Turnpike would be about 20 minutes, including time to park. With the assumed operating plans for Worcester trains and I-290 trains east of Framingham, the time to South Station from Route 9 & 90 would be four minutes less than the time from Southborough Station. This would still result in an overall travel time saving of 11 minutes via Southborough Station.

A third alternative for Hopkinton residents would be to go to the D'Angelo Drive station on the I-290 extension via I-495. This would require a driving time of about 15 minutes, or five minutes less than the time to Route 9 & 90 but the on-train time from D'Angelo Drive would be 10 minutes longer. This would result in an overall travel time increase of 5 minutes compared with going to Route 9 & 90 or 16 minutes compared with going to Southborough.

Because of road layout most residents of the older, more densely developed sections of Hopkinton would go through the town center on the way to either the Southborough station, Route 9 & 90, or D'Angelo Drive. For such access trips, the travel time differences would be the same as indicated above for trips originating at the town center.

Much of the recent residential development in Hopkinton has occurred in the area west of I-495. Residents of that area going to I-495 on the way to a Route 9 & 90 station would also use the West Main Street interchange. Even for trips starting directly at this interchange, however, using the Southborough station would result in overall travel time savings to Boston of about 4 minutes compared with Route 9 & 90 or 9 minutes compared with D'Angelo Drive. Not all trips from west of I-495 would have to use west Main Street to reach the Southborough station. For those that did not, the savings from using Southborough would be even greater. With continuation of tolls on the Mass. Turnpike, boarding at Route 9 & 90 would be more expensive than boarding at Southborough. Both stations would be in fare Zone 6, but there is a 25-cent toll from I-495 to Interchange 12. Hopkinton passengers boarding at D'Angelo Drive would not have to pay any toll, but would have to pay Zone 7 rail fares. The added cost per one-way trip would range from 19 cents using a pass to 25 cents with a single-ride ticket.

The main incentive for Hopkinton residents to use a Route 9 & 90 station would be insufficient parking capacity at Southborough. The present plan for the Southborough station calls for 420 parking spaces there. This appears to be adequate based on the

total travel to Boston and Cambridge from Southborough, Hopkinton, and neighboring towns, and the likely rail shares and access modes. In the event of parking constraints at Southborough, Hopkinton residents would be more likely to shift to Ashland than to Route 9 & 90.

Other Origins
South of Hopkinton on I-495 the next two interchanges are at Route 85 and at Route 109 in Milford. The 1993 survey results show that commuter rail boardings by Milford residents were divided among several stations. The single most heavily used of these was Forge Park Station in Franklin, at the end of the Franklin Line. The average reported access time from Milford to Forge Park was 14.5 minutes. From Milford to a Route 9 & 90 station via I-495 and the Mass. Turnpike, average access time would be about 25 minutes, or 10.5 minutes longer than the time to Forge Park.

Scheduled running times from Forge Park to South Station vary with the number of intermediate stops. In recent years, the fastest scheduled time has been 54 minutes, so the fastest estimated train time from Route 9 & 90 to South Station would be 15 minutes faster than this. Including access times, going to Route 9 & 90 would save an average of 4.5 minutes of travel time for Milford residents compared with the fastest trains from Forge Park. Even greater savings could be achieved by going from Milford to the Southborough station, however. This would be the case using either a combination of I-495, West Main Street, and Route 85, or taking Route 85 all the way from Milford to Southborough. Therefore, it is unlikely that many Milford residents would be attracted to a Route 9 & 90 station. Likewise, that station would not attract many riders from towns further south along I-495.

Points Served by Interchanges 11 and 10A South of Turnpike

Millbury
West of Interchange 11A, the next entry point to the turnpike is Interchange 11 in Millbury. It is 9.7 miles from Interchange 11A, and 14.9 miles from Interchange 12. Interchange 11 connects with state Route 122 in the extreme northeast corner of Millbury, near the border of Grafton. A new interchange (10A) recently opened at Route 146 in the northwest corner of Millbury, about two miles west of Interchange 11.

Access to Interchange 11 for most Millbury residents requires use of either local roads or a circuitous path on state routes 146 and U.S. Route 20. The latter path goes past Interchange 10A, which would be expected to divert most Turnpike traffic going from Millbury this way.

The 1993 commuter rail survey found no Millbury residents using lines in operation at that time. The 1990 Census results showed a total of 78 work trips from Millbury to all of Boston or Cambridge, but none using public transportation. The 1995 Worcester Station survey found five Millbury residents boarding there for work trips to Boston. The new station opened in February 2000 in Grafton on the Framingham / Worcester Line will be more convenient than Worcester Station for most Millbury residents, as it

will reduce both access time and on-train time. Nevertheless, a January 2001 license plate survey found only four vehicles from Millbury parked in the Grafton Station lots at midday. Some of these may have been diverted from Worcester Station.

Using Grafton Station, total travel time from downtown Millbury to South Station (excluding waiting time at the station) will be about 71 minutes on a train making limited stops east of Framingham. The total travel time from downtown Millbury to South Station using the Turnpike and an express train from a Route 9 & 90 station would be about 68 minutes. This saving of 3 minutes would occur only if the train from Route 9 & 90 ran non-stop between Framingham and Back Bay and the train from Grafton stopped at West Natick or Natick and then ran non-stop to Back Bay. The overall time saving would be too small to attract many commuter rail riders from Millbury who would not otherwise board at Grafton.

The present Turnpike toll from Millbury to Interchange 12 is 65 cents. Under the Fall 2000 fare structure, a monthly pass user would save an average of only 33 cents each way by boarding at Route 9 & 90 (Zone 6) instead of at Grafton (Zone 8). A 12-ride ticket user would save 69 cents by boarding at Route 9 & 90 and a single-ride ticket user would save 75 cents. Although these would exceed the extra toll cost, for most passengers the savings would be too small to be a deciding factor in choosing a boarding location.

The Grafton Station parking lot originally had 270 spaces. By the end of 2000, these were all filled to capacity by the end of the A.M. peak, and by midday about 60 additional vehicles were parked in a nearby office park lot. In March 2001 the MBTA was finalizing plans to expand the Grafton Station lot capacity by about 100 spaces. A January 2001 license plate survey at this station found that many of the parked vehicles were from origins that would be more conveniently served by one of the additional stations being built between Grafton and Framingham, or by expansion of municipal parking near Worcester Station. Based on the total travel to Boston and Cambridge from Grafton, Millbury, and neighboring towns, and the likely rail shares and access modes, parking capacity at Grafton after the expansion there and at other stations should prove to be adequate. Originally there was also to have been a station in Millbury near Interchange 11. This station has been dropped from present plans because Millbury town officials felt that it would be used mostly by residents of other towns. This does not preclude future reconsideration of a Millbury station if use of other stations by Millbury residents is found to be contributing significantly to capacity problems at those stations.

Other Origins

Residents of some towns to the south of Millbury would drive through downtown Millbury to go to either the Mass. Turnpike or the Grafton commuter rail station. For such trips, the commuter rail time difference between Grafton and Route 9 & 90 would be the same as for trips originating in downtown Millbury.

The next town to the south of Millbury is Sutton. The 1993 commuter rail survey found no Sutton residents using lines in operation at that time. The 1990 Census results showed a total of 29 work trips from Sutton to all of Boston, but none to Cambridge, and none using public transportation. The 1995 Worcester Station survey found four Sutton residents boarding there for work trips to Boston. The January 2001 license plate survey at Grafton Station showed 13 vehicles from Sutton parked there at midday, possibly including some diversions from Worcester Station. As in the case of Millbury, the commuter rail travel time improvement via Route 9 & 90 would be insufficient to attract many Sutton residents who would not otherwise use the Grafton Station, and the combined tolls and fares via Route 9 & 90 would be either higher or only slightly lower.

The next town south of Sutton is Douglas. Because of highway layout, Douglas residents going to the Mass. Turnpike would be more likely to use Interchange 10 than either of the Millbury interchanges, so Douglas is discussed in the Interchange 10 section below.

Points Served by Interchanges 11 and 10A North of Turnpike

Interchange 11 has historically been a main access point to the Mass. Turnpike for eastbound traffic originating in Worcester or passing through Worcester from points further north. Much of this traffic is expected to be diverted to the new Interchange 10A, which will require driving for a shorter distance on a non-limited-access highway.

At present, the majority of Worcester residents who use commuter rail board at Worcester Station. From starting points in Worcester west of I-290 or north of Shrewsbury Street, driving to a train at a Route 9 & 90 station via either Interchange 10A or Interchange 11 would increase travel time to Boston compared with driving to a train at Worcester Station. Likewise, there would be no travel time savings in driving to a Route 9 & 90 station from any town from which the fastest route would involve driving through Worcester to interchanges 10A or 11.

An I-290 / Northborough station would be more competitive with Worcester Station than would a Route 9 & 90 station for trips originating north of the center of Worcester. For traffic approaching downtown Worcester from the north via Route I-190, the routes to Worcester and to Northborough would split at the junction of I-290. With the assumed train times to Boston from each of these terminals, going via I-290 / Northborough would save only about 2.5 minutes compared with going via Worcester, but access time to Worcester would be about 10 minutes less. With the small difference in overall travel times it is unlikely that the I-290 / Northborough station would attract many riders from points along the I-190 corridor who would not otherwise have used Worcester Station.

The relative travel time advantage of Northborough would increase at points along I-290 between I-190 and the Shrewsbury border. (Shrewsbury is already assumed to be in the I-290 / Northborough service area.) Much of the area between I-290 and Shrewsbury Street is occupied by a large park and by various medical institutions, so

there is little potential journey-to-work travel to be attracted to a Northborough station from there. North of I-290 street layout results in much traffic flowing more easily to I-190 or to the interchanges on I-290 close to I-190 than to the interchanges closer to Shrewsbury. This further limits the competitive advantage of Northborough for Worcester riders. Again, most of those attracted to Northborough would be diversions from Worcester Station.

From points east of I-290 along Route 146 or Route 122 or streets adjoining these, there would be some travel time savings from using a Route 9 & 90 station rather than the Worcester Station. The savings would be greatest at the Worcester city limits, ranging up to about 15 minutes on Route 122 and about 13 minutes on Route 146. Population density in each of these corridors is lowest near the city limits and highest near I-290. This would result in average savings of about five minutes along Route 122 and seven minutes along Route 146. These savings would be contingent on running times for I-290 trains being five minutes less than those of Worcester trains between Framingham and Boston. The neighborhoods where the savings would be experienced account for less than 10% of the total population of Worcester. Many of the residents of this area would be likely to choose Worcester Station because of the shorter access distance despite longer total travel time. For passengers using single-ride or 12-ride tickets, the fare saving at Route 9 & 90 compared with Worcester would exceed the toll to Interchange 12 from Interchange 11 or Interchange 10A by up to 85 cents per trip. For monthly pass users, the toll would exceed the fare saving by about 8 to 18 cents per trip, however. (In the 1995 survey 71% of Worcester residents who boarded at Worcester Station were pass users.)

In summary, a Route 9 & 90 station could be expected to attract some riders from Worcester, but the number of these who would not otherwise use commuter rail would be small.

Points Served by Interchange 10

Location of Interchange
West of Interchange 10A, the next entry point to the turnpike is Interchange 10 in Auburn. It is 4.3 miles from Interchange 10A, and 21.2 miles from Interchange 12. At Interchange 10 the Turnpike connects with State Route 12, U.S. Route 20, and Routes I-290 and I-395 through a very complex arrangement of ramps. I-395 ends and I-290 begins there. All of this occurs within a short distance of the town center of Auburn.

Cities and Towns on I-290
North of Interchange 10, I-290 has one interchange in Auburn. This town is discussed in the I-395 section. Beyond that, the next 11 interchanges on I-290 are all within Worcester. From most points in Worcester, overall travel times to points further east on the Turnpike would be longer by using I-290 to Interchange 10 than by using Route 146 to Interchange 10A or Route 122 to Interchange 11. The same would hold true for trips passing through Worcester on the way to the Turnpike. Therefore, the number of trips

from Worcester or points north going to a Route 9 & 90 station via Interchange 10 would be expected to be insignificant.

Towns Directly on Route I-395

The 1993 commuter rail survey found only three Auburn residents using lines in operation at that time, all boarding at Framingham. The 1990 Census results showed a total of 109 work trips from Auburn to all of Boston or Cambridge, but none using commuter rail and only 10 using any form of public transportation. The 1995 Worcester Station survey found 12 Auburn residents boarding there for work trips to Boston or Cambridge, including one diversion from Framingham. The January 2001 Grafton Station license plate survey found only one vehicle from Auburn parked there at midday.

Most of the residential development in Auburn is in the northern two thirds of the land area, between Route 20 and the border of Worcester. From points along Route 20, driving to a Route 9 & 90 station via the Mass. Turnpike to board a train would result in overall travel time savings of about 10 minutes compared with driving to Worcester Station via I-290 to board. Survey results from present MBTA commuter rail lines show that some riders choose a boarding station to minimize total travel time, some choose to minimize access time, and some make a compromise between the two extremes. For those who read or work while riding on the train, the extra time on board may be regarded as more worthwhile than the access time saving.

In the case of Auburn, the 10-minute travel time saving via Route 9 & 90 would be at the expense of more than 20 minutes of added access time. It is likely therefore, that many residents of this area would still prefer to use Worcester Station. Residents of sections of Auburn north of the Mass. Turnpike can enter I-290 to go to Worcester Station at either Auburn Street in Auburn or at Hope Avenue in Worcester. The further north the starting point is, the smaller the advantage would be of going to Route 9 & 90.

For passengers using single-ride or 12-ride tickets, the fare saving at Route 9 & 90 compared with Worcester would exceed the 85-cent toll to Interchange 12 from Interchange 10 by 65 or 53 cents For monthly pass users, the toll would exceed the fare saving by 28 cents, however.

The next town to the south of Auburn on I-395 is Oxford. There are two direct entry points to I-395 within Oxford. From the northeast corner of the town (Oxford Heights) access to I-290 or the Turnpike is shorter by taking Route 12 or Route 20 to Auburn than by taking I-395 from Oxford. For trips entering I-395 in Oxford, the time advantage via Route 9 & 90 compared with Worcester would be slightly less than from the center of Auburn. This is because I-395 and I-290 make an end-to-end connection, but the connection from I-395 to the Turnpike is very circuitous.

The 1993 commuter rail survey found no Oxford residents using lines in operation at that time. The 1990 Census results showed a total of 48 work trips from Oxford to all of Boston or Cambridge, but none using any form of public transportation. The 1995

Worcester Station survey found seven Oxford residents boarding there for work trips to Boston or Cambridge. The January 2001 Grafton Station license plate survey found no vehicles from Oxford parked there at midday.

The next town south of Oxford on I-395 is Webster, which has three interchanges. From there the commuter rail travel time differences between Route 9 & 90 and Worcester would be slightly less than from Auburn for reasons cited above.

The 1993 commuter rail survey found no Webster residents using lines in operation at that time. The 1990 Census results showed a total of 76 work trips from Webster to all of Boston but none to Cambridge. Seven of the these trips were made by bus, but none by any other form of public transportation. The 1995 Worcester Station survey found three Webster residents boarding there for work trips to Boston or Cambridge. The January 2001 Grafton Station license plate survey found no vehicles from Webster parked there at midday.

Other Origins

Webster is the last Massachusetts town on I-395 before that highway enters Connecticut. I-395 can also be used for access to the Mass. Turnpike or Worcester from some towns adjoining those it passes directly through. As detailed below, none of these towns are large generators of trips to Boston by any mode. The travel time improvement of express service from a Route 9 & 90 station compared with present express service from Worcester would be too small to attract significant numbers of either new or diverted riders from these towns.

Auburn is bordered on the east by Millbury, which has two interchanges on the Turnpike, as discussed above, so Millbury residents would not use I-395 for access to either the Turnpike or Worcester. To the west, Auburn is bordered by Oxford, which is discussed above as a town directly on I-395, and by Leicester. The latter town also borders directly on Worcester, so the most direct routes to Worcester Station from Leicester do not pass through Auburn. There is also more direct access from Leicester to the Turnpike through Worcester than through Auburn, but it is less direct than the access to Worcester Station.

Driving from Leicester through Worcester to a Route 9 & 90 station would result in little or no travel time saving to Boston compared with driving to Worcester Station. The 1993 commuter rail survey found no Leicester residents using lines in operation at that time. The 1990 Census showed only 16 work trips from Leicester to all of Boston or Cambridge. In the 1995 survey only three Leicester residents used Worcester Station. It is unlikely that a larger number of Leicester residents than this would be attracted to a Route 9 & 90 station. The January 2001 Grafton Station license plate survey found no vehicles from Leicester parked there at midday.

Oxford is bordered to the east by Sutton, but that town has more direct connections to the Turnpike and Worcester through Millbury than through Oxford. To the west, Oxford is bordered by Charlton. From that town, the fastest access to either Worcester

or the Mass. Turnpike is via Route 20 through Oxford to the Auburn interchange complex. The differences in access times and in combined fares and tolls between commuter rail via Worcester and via Route 9 & 90 would be the same as for trips starting in Auburn. The 1993 commuter rail survey found no Charlton residents using lines in operation at that time. The 1990 Census results showed a total of only 16 work trips from Charlton to all of Boston or Cambridge, but none using any form of public transportation. The 1995 Worcester Station survey found six Charlton residents boarding there for work trips to Boston. The January 2001 Grafton Station license plate survey found only one vehicle from Charlton parked there at midday.

Webster is bordered to the east by Douglas. From most points in that town, the fastest (though not always the shortest) path to the Turnpike or Worcester would be through Webster to I-395. The 1993 commuter rail survey found only one Douglas resident using a line in operation at that time. This was a work trip to Boston, boarding at Forge Park. The 1990 Census results showed a total of 21 work trips from Douglas to all of Boston but none to Cambridge and none by any form of public transportation. The 1995 Worcester Station survey found no Douglas residents boarding there for any trip purpose. The January 2001 Grafton Station license plate survey found only four vehicles from Douglas parked there at midday.

To the west, Webster is bordered by Dudley. From that town, the fastest paths to the Turnpike or Worcester would be through Webster or Oxford to I-395. The 1993 commuter rail survey found no Dudley residents using lines in operation at that time. The 1990 Census results showed a total of only 33 work trips from Dudley to all of Boston but none to Cambridge, and none using any form of public transportation. The 1995 Worcester Station survey found two Dudley residents boarding there for any purpose, and only one was making a repetitive work trip to Boston. The January 2001 Grafton Station license plate survey found no vehicles from Dudley parked there at midday.

From most towns other than those discussed above for which Interchange 10 is the nearest access point to the Mass. Turnpike, driving times to a Route 9 & 90 station would exceed 50 minutes. As discussed elsewhere in this appendix, 50 minutes is the *de facto* limit on the length of time that MBTA commuter rail users have been observed to be willing to drive to a station. It is reasonable to assume that the same would hold true at a Route 9 & 90 station, so it is unnecessary to consider other towns in the Interchange 10 service area specifically.

In summary, passengers going to a Route 9 & 90 station via the Mass. Turnpike from Interchange 10 would have trip origins in towns along Route I-395 south of the Turnpike, or in towns directly adjoining these. This group of towns generates a relatively small number of work trips to Boston and Cambridge, and Worcester Station captures a fairly small share of that limited market. Residents of these town would save about 10 minutes in total travel time to Boston by boarding at Route 9 & 90 instead of Worcester if I-290 extension trains ran non-stop from Framingham to Back Bay, and if Worcester train made local stops as far as West Natick or Natick. The driving portions

Table F-1
Interchange 10 Service Area Towns
Total Boston and Cambridge Work Trips and Rail Shares

Town	1990 Total Boston and Cambridge Work Trips	1995 Boston and Cambridge Work Trips via Worcester Station	Jan. 2001 Vehicles from Town at Grafton Station
Auburn	109	12	1
Oxford	48	7	0
Webster	76	3	0
Charlton	16	6	1
Douglas	21	0	4
Dudley	33	1	0
Total	303	29	6

Note: Total Worcester Station boardings were 82% higher in 1998 than at the time of the 1995 survey

of their trips would increase by about 20 minutes, however. For those using monthly passes, combined rail fares and tolls would be higher via Route 9 & 90 than via Worcester. (The added auto operating costs for longer driving distances have not been taken into account.) For these reasons, it is unlikely that a Route 9 & 90 station would derive significant ridership from this group of towns.

Points Served by Interchange 9

Location of Interchange
West of Interchange 10, the next entry point to the Turnpike is Interchange 9 in Sturbridge. It is 11.7 miles from Interchange 10, and 32.9 miles from Interchange 12. At Interchange 9 the Turnpike only connects directly with Route I-84, which begins there and runs southwest into Connecticut. Access to the Turnpike from other highways and local roads is provided by an interchange between I-84 and U.S. Route 20 about one mile south of Interchange 9. This interchange is also in Sturbridge, as are the only other two interchanges on I-84 within Massachusetts.

Sturbridge
Sturbridge residents would use the Turnpike from Interchange 9 to go either to a Route 9 & 90 station or to Worcester Station. The total driving time to a Route 9 & 90 station from Route 20 at I-84 would be about 43 minutes. The time for most trips routed via Interchange 9 would be longer than this. With the observed upper bound of about 50 minutes on access time, a Route 9 & 90 station would attract few riders via Interchange 9 from points more than 7 minutes from the center of Sturbridge.

From the center of Sturbridge to Worcester, driving time would be about 27 minutes, or 16 minutes less than the time to Route 9 & 90. The shorter on-train time would give

Route 9 & 90 an overall travel time advantage of 14 minutes, however. These differences would also apply to traffic entering the Turnpike west of Interchange 9.

The 1990 Census results found only 15 work trips to Boston and 18 to Cambridge from Sturbridge despite good highway access via I-84 and the Turnpike. None of these trips were made by public transportation of any form. The 1993 commuter rail survey found no Sturbridge residents using lines in operation at that time. The 1995 Worcester Station survey found one Sturbridge resident boarding there for a work trip to Boston but none there for other purposes. The January 2001 Grafton Station license plate survey found one vehicle from Sturbridge parked there at midday.

Other Origins
Sturbridge is the last town on I-84 in Massachusetts before the Connecticut border. To the east, Sturbridge is bounded by Charlton (discussed under Interchange 10) and by Southbridge. From points in Southbridge west of the town center the fastest access to the Turnpike is via state Route 131 to I-84 in Sturbridge. From east of the center the fastest access is through Charlton to Interchange 10 in Auburn.

The 1990 Census results found only 10 work trips to Boston and nine to Cambridge from Southbridge, including four made in part by subway. The 1993 commuter rail survey found two Southbridge residents boarding at Natick for work trips to Boston. The 1995 Worcester Station survey found one additional Southbridge resident boarding there for a work trip to Boston along with one passenger making a non-repetitive trip. The January 2001 Grafton Station license plate survey found two vehicles from Southbridge parked there at midday.

To the west, Sturbridge is bordered by Brimfield and Holland. From Brimfield, the fastest access to the Turnpike is via Route 20 to I-84 in Sturbridge. From Holland the fastest access is via local roads to Route 20 in Brimfield, then continuing as above. The 1990 Census results found only eight work trips to Boston from Brimfield and four from Holland, with no trips to Cambridge and no trips by public transportation from either. Neither town had any commuter rail riders in either the 1993 or 1995 surveys or the Grafton license plate survey.

To the north, Sturbridge is bordered by Brookfield and East Brookfield. From Brookfield, the fastest access to the Turnpike is via routes 148 and 20 to I-84 in Sturbridge. From East Brookfield the fastest access is via local roads, and routes 49 and 20 to I-84 in Sturbridge. The 1990 Census results found only seven work trips to Boston but none to Cambridge from Brookfield. There were two trips each to Boston and Cambridge from East Brookfield. None of the trips from either town used public transportation. There were no trips from Brookfield in either commuter rail survey. The 1995 survey showed one Boston work trip from East Brookfield boarding at Worcester. The Grafton License plate survey found no vehicles from Brookfield or East Brookfield.

Table F-2
Interchange 9 Service Area Towns
Total Boston and Cambridge Work Trips and Rail Shares

Town	1990 Total Boston and Cambridge Work Trips	1995 Boston and Cambridge Work Trips via Worcester Station	Jan. 2001 Vehicles from Town at Grafton Station
Sturbridge	33	1	1
Southbridge	19	1	2
Brimfield	8	0	0
Holland	4	0	0
Brookfield	7	0	0
East Brookfield	4	1	0
Total	75	3	3

Note: Total Worcester Station boardings were 82% higher in 1998 than at the time of the 1995 survey

In summary, Census figures show that the towns served by Turnpike Interchange 9 generate few trips to Boston or Cambridge by any means of transportation. The Worcester Station survey showed that commuter rail service from there was able to capture only a small share of this small market. A Route 9 & 90 station could provide residents of towns in the Interchange 9 service area with overall travel times to Boston about 14 minutes faster than will be offered via Worcester after intermediate stations west of Framingham are opened. This would be a reduction of only four minutes compared with the scheduled times from Worcester when the 1995 survey was conducted, however. From most points served by Interchange 9, driving times to a Route 9 & 90 station would exceed the observed upper limit of 50 minutes for most commuter rail access trips. For these reasons, a Route 9 & 90 station could not be expected to attract significant numbers of riders via the Turnpike from Interchange 9.

Points Served by Interchange 8

Location of Interchange

West of Interchange 9, the next entry point to the Turnpike is Interchange 8 in Palmer. It is 15.7 miles from Interchange 9, and 48.6 miles from Interchange 12. At Interchange 8 the Turnpike only connects directly with state Route 32, which provides connections to Route 20 and local roads.

Palmer

Palmer residents would use the Turnpike from Interchange 8 to go either to a Route 9 & 90 station or to Worcester Station. The total driving time to a Route 9 & 90 station from the end of the Turnpike access ramp on Route 32 would be about 55 minutes. This would exceed the observed upper bound of about 50 minutes on commuter rail access time, and for most trips routed via Interchange 9 access times would be even longer.

Therefore, a Route 9 & 90 station would attract few if any riders via the Turnpike from Interchange 8.

The access time from Interchange 8 to Worcester Station is about 39 minutes, but no trips from Palmer were reported in the Worcester Station survey (and none had been reported in the 1993 survey). The 1990 Census found a total of only 19 work trips to Boston and none to Cambridge from Palmer despite good highway access via the Turnpike. None of these trips were made by public transportation of any form.

Other Origins
Palmer is bounded to the east by Brimfield (discussed above under Interchange 9) and by Warren. Residents of Warren traveling east on the Turnpike would be more likely to follow various paths to Interchange 9 than to double back to Interchange 8. The 1990 Census found only 6 work trips to Boston (none by public transportation) and no trips to Cambridge from Warren. There were no trips from Warren in either commuter rail survey.

To the west Palmer is bounded by Wilbraham, which connects with the Turnpike via Route 20 to Palmer. The 1990 Census found no work trips to Boston or Cambridge from Wilbraham. The 1993 survey also had no Wilbraham trips, but the 1995 survey had two work trips to Boston boarding at Worcester. These trips both had reported access times of 45 minutes to Worcester, so times to Route 9 & 90 from the same origins would have been about 61 minutes.

To the south Palmer is bounded by Monson, which connects with the Turnpike via Route 32 to Palmer. The 1990 Census found only 9 work trips to Boston (none by public transportation) and no trips to Cambridge from Monson. There were no trips from Monson in either commuter rail survey.

To the north Palmer is bounded by Ware, which connects with the Turnpike via Route 32 to Palmer, and by Belchertown, which connects with the Turnpike via Route 181 to Palmer. The 1990 Census found 13 work trips to all of Boston (none by public transportation) and no trips to Cambridge from Ware. From Belchertown, the Census found 19 work trips to Boston and 8 to Cambridge, but none by public transportation. There were no trips from Ware or Belchertown in either commuter rail survey.

Monson is bounded to the east by Wales and to the west by Hampden. From either of these towns Interchange 8 can be accessed by taking local roads to Route 32. Residents of Wales would be more likely to access the Turnpike for eastbound trips by taking Route 19 to Route 20 to Interchange 9, however. The 1990 Census found 6 work trips to all of Boston (none by public transportation) and no trips to Cambridge from Wales. No trips were found from Hampden. Neither commuter rail survey had any trips from either town.

Table F-3
Interchange 8 Service Area Towns
Total Boston and Cambridge Work Trips and Rail Shares

Town	1990 Total Boston and Cambridge Work Trips	1995 Boston and Cambridge Work Trips via Worcester Station	Jan. 2001 Vehicles from Town at Grafton Station
Palmer	19	0	1
Warren	6	0	0
Wilbraham	0	2	0
Monson	9	0	0
Ware	13	0	0
Belchertown	27	0	1
Wales	6	0	0
Hampden	0	0	0
Total	80	2	2

Of the towns discussed above served by Interchange 8, only Palmer and Belchertown were the sources of any vehicles parked at Grafton Station in the January 2001 survey. There was one vehicle from each of them there at midday.

In summary, Census results show that towns in the service area of Interchange 8 generate few work trips to Boston by any means of transportation. The 1995 survey results show that commuter rail service from Worcester captured only a very small share of this limited market. Commuter rail service from a Route 9 & 90 station would at best improve travel times to Boston by only about 4 minutes compared with the Worcester service provided at the time of the survey. Access times to Route 9 & 90 from throughout the Interchange 8 service area would exceed the observed limit acceptable to most commuter rail riders. Therefore, a Route 9 & 90 station could be expected to attract few or no riders via the Turnpike from Interchange 8.

Points Served by Interchanges West of Interchange 8

West of Interchange 8, the next interchange on the Turnpike is Interchange 7 in Ludlow. It is 7.9 miles from Interchange 8, and 56.5 miles from Interchange 12. At Interchange 7 the Turnpike only connects directly with state Route 21, which provides connections to local roads.

As detailed above, even from towns served by Interchange 8 access times to a Route 9 & 90 station would exceed the maximum reported by almost all users of regional park-and-ride facilities at MBTA commuter rail stations in past surveys. Trips to Route 9 & 90 from any point on the Turnpike west of Interchange 8 would require longer access times, so the number of such trips attracted to the station is likely to be negligible.

In the 1995 survey, Worcester Station attracted only three riders who would have used the Turnpike from west of Interchange 8 for their access trips. All three had trip origins in Springfield, which has the largest total population of any Massachusetts city west of Worcester, and which also generates by far the largest number of Boston and Cambridge work trips of any town city or town west of Interchange 8. Two of the three trips had reported access times to Worcester Station of 45 minutes (which appears to be slightly understated) and the third had a reported time of 60 minutes. The latter trip was the only one to Worcester from anywhere with a reported access time exceeding 45 minutes. The 2001 Grafton Station license plate survey found only two vehicles parked there registered in towns from which probable access to Grafton would have included use of the Mass. Turnpike from west of Interchange 8.

In conclusion, a Route 9 & 90 station would attract few if any riders via the Mass. Turnpike from any point west of Interchange 8 in Palmer.

Service Areas of Existing Commuter Rail Regional Park-and-Ride Facilities

As part of the process of estimating the market area for a station at Routes 9 and I-90 in Framingham, an examination was made of ridership patterns at regional park-and-ride facilities on present MBTA commuter rail lines. Nine such stations were identified, including seven on lines terminating at South Station (as an I-290 extension would) and two on lines terminating at North Station. Findings for these stations are discussed below.

South Attleboro

This station on the Attleboro / Stoughton Line is located just off the Route 1A / Newport Avenue interchange of Route I-95 near the Rhode Island border. It was opened as an entirely new station in 1990. It was intended primarily to serve Rhode Island passengers and reduce demand for parking at other stations in Massachusetts, and it does serve those purposes. In the 1993 survey, 83% of the riders at this station used park-and-ride access and another 13% were dropped off. Only 9% had trip origins in Attleboro, and only 6% had origins anywhere else in Massachusetts. The other 85% had origins in Rhode Island. Attleboro, together with adjoining cities and towns in both states, accounted for 39% of trip origins of passengers using the station. The largest single origin point was Providence, with 17.6%, even though Providence has direct service on the same route and does not adjoin Attleboro. This was partly because Providence has by far the largest total population of any of the cities and towns sending riders to South Attleboro Station.

Among the explanations for the use of South Attleboro Station rather than Providence Station by Providence residents is that South Attleboro has slightly more frequent peak service, has midday and evening service, which Providence Station did not at the time of the survey, and costs less to use. South Attleboro is not only in a lower fare zone (Zone 7 versus Zone 9) but also has much lower parking fees. At South Attleboro, the MBTA lots charge $1.00 per day and there is also substantial free parking in an

adjoining shopping mall. At Providence parking fees range from $4.50 to $6.50 per day, exceeding the train fare for most riders. Despite these disadvantages, more than twice as many Providence residents used Providence Station as used South Attleboro in 1993.

Only 6% of South Attleboro patrons had trip origins in Rhode Island cities or towns that were neither on limited-access highways with uninterrupted connections to South Attleboro nor served by interchanges on such highways in adjoining towns.

Route 128

This station on the Attleboro / Stoughton Line is located just off the University Avenue interchange of Route 128 / I-95, overlapping the borders of Dedham and Westwood, and adjoining the border of Canton. It is the oldest of all of the park-and-ride stations analyzed, having first opened in 1953. It was originally intended mainly for intercity rail passengers going to New York, but is now used predominantly by Boston commuters. At the time of the survey, Route 128 had 795 parking spaces in MBTA-owned surface lots and 250 additional spaces in a town lot and on nearby streets. Parking for commuters and intercity train riders was not separated. The MBTA lot was replaced in early 2000 by a garage with 2,250 spaces for commuters and 500 for intercity train riders.

In the 1993 survey, 87% of the commuter rail riders at this station used park-and-ride access. Origins were much less dispersed than at South Attleboro, with 66% of riders having trip ends in Westwood, Dedham, Canton, or a town directly adjoining one of these. This was largely attributable to the availability of commuter rail service at many other locations further south, on the same lines serving Route 128 and on other lines. The 34% of Route 128 users with trip origins further away than adjoining towns included only 4% from towns without continuous limited-access highway connections to Route 128 Station. The largest number from a non-adjoining town with direct rail service was 27 (2.3%) from Mansfield. The number of trips with Mansfield origins made by boarding at Mansfield Station was 28 times as large as the number boarding at Route 128.

Information on origins of riders with the new station configuration is unavailable. An April 2000 CTPS count found that parking utilization had not yet returned to pre-construction levels.

Dedham Corporate Center

This station on the Franklin Line is located just off the East Street interchange of Route 128 / I-95 in Dedham. Like South Attleboro, it was opened as an entirely new station in 1990. It was intended to reduce excess demand at Route 128 Station (discussed above) but was initially unsuccessful because of less convenient access and less frequent service. It was found necessary to offer free parking at Dedham Corporate Center in order to compete with Route 128.

In the 1993 survey, 97% of the riders at this station used park-and-ride access. Dedham and directly adjoining towns accounted for 61% of the trip origins. Another 17% came from Norwood. The northern border of Norwood is only about one mile from the Dedham Corporate Center Station, separated by a part of Westwood. Norwood is served directly by two stations on the Franklin Line, but they are in a higher fare zone (Zone 3 versus 2) and each had a $1.00 parking fee versus free parking at Dedham Corporate Center in 1993. From some origins in Norwood passengers would need to double back to reach one of the stations within the town. Despite the advantages of Dedham Corporate Center, it attracted less than one tenth as many Norwood passengers as used the two Norwood stations combined.

Although the survey showed 20 cities and towns generating trips with boardings at Dedham Corporate Center, the top six accounted for 91% of the total. The other 14 accounted for only one to four passengers each. The largest number of riders from a town not directly adjoining Dedham and without a direct limited-access highway connection to the station was 39 (8.3%) from Medfield. Nearly five times this many riders from Medfield used the station in the adjoining town of Walpole, also on the Franklin Line.

One reason that Dedham Corporate Center serves a smaller area than Route 128 Station is that Dedham Corporate Center is further from the most heavily used highway route into Boston. Most traffic from points along I-95 south of Route 128 continues to Boston by turning east and north on Route I-93. The University Avenue interchange serving Route 128 Station is 0.5 miles west of the I-95/I-93 interchange. The East Street interchange serving Dedham Corporate Center is an additional 1.1 miles west of University Avenue. Traffic going from I-95 south of Route 128 to Dedham Corporate Center has to pass Route 128 Station first. Both stations are in fare Zone 2. At the time of the survey Dedham Corporate Center offered free parking compared with $1.00 parking fee for most of the Route 128 Station spaces, but Route 128 offered faster scheduled times to Boston and more frequent departures.

Forge Park

This station is located just off the Route 140 interchange with I-495 in Franklin. It was opened in 1988 as an entirely new station, and also became the new outer terminal for the Franklin Line. It is 2.8 miles beyond the former terminal, on a rail line that had been used only for freight service for many years. This station was built as the result of a site being made available to the MBTA by the developers of the Forge Park office complex. An extension to that point had not previously been under consideration.

In the 1993 survey 84% of the riders at this station used park-and-ride access. Franklin and directly adjoining towns accounted for 56% of the trip origins, placing Forge Park at the average of South Attleboro, Route 128, and Dedham Corporate Center in terms of proportion of ridership from nearby origins. Beyond Franklin and adjoining towns, the largest source of Forge Park ridership was Milford, at 17%. Milford has a direct link to Forge Park via I-495, with two interchanges 5.2 and 7.0 miles from Route 140.

Although the survey showed 20 cities and towns generating trips with boardings at Forge Park, the top seven accounted for 90% of the total. The other 13 accounted for only two to 14 passengers each. The largest number of riders from a town not directly adjoining Franklin and without a direct limited-access highway connection to the station was 45 (7.0%) from Hopedale. Riders from Hopedale can access Forge Park either via Route 140 or by taking Routes 16 and 109 to I-495 in Milford. Forge Park is the nearest commuter rail station to Hopedale, and was the boarding point for 92% of the survey rail trips originating there. The remainder boarded at Franklin Station. For most of the rest of the Forge Park trips originating outside Franklin or adjoining towns, the only competing rail service was also Franklin Station.

Mishawum

This station is on the Lowell Line at the Mishawum Road interchange of Route 128/I-95 in Woburn. It opened in 1984 as a new station, intended mainly for park-and-riders but also acting as a replacement for the Woburn Branch commuter rail line, which had been discontinued in 1981. It is about 2.5 miles by road from the former downtown Woburn Station. In April 2001 a new station, Anderson/Woburn, with much greater parking capacity opened one mile further north. Service at Mishawum was discontinued except for three outbound A.M. peak and three inbound P.M. peak trips for reverse commuters.

The 1993 survey results show that only 57% of Mishawum riders used park-and-ride access. Walk-ins accounted for the second-largest share, at 21%, but these occurred predominantly on return halves of reverse-commuting trips from nearby office and industrial parks. For purposes of this analysis the service area of Mishawum Station is best examined in terms of park-and-ride and kiss-and-ride access alone.

Among passengers using some form of auto access to Mishawum, 75% had trip origins in either Woburn or an adjoining town, with Woburn alone accounting for 48%. The largest single source of riders from a town not adjoining Woburn was Billerica, with 28 (9%). Billerica has direct service via the Lowell Line at North Billerica Station, but it is in a higher fare zone (Zone 5 versus Zone 2). The location of North Billerica Station forces many town residents to double back to use it. Also, at the time of the survey there were many complaints about theft or damage of vehicles parked at North Billerica. Despite these disadvantages, the number of Billerica residents boarding trains at North Billerica was more than five times the number boarding at Mishawum.

Excluding Billerica, no city or town that did not adjoin Woburn accounted for more than 10 auto-access trips to Mishawum. Almost all of the communities that originated Mishawum trips had continuous limited-access highway connections to the station via Route 128/I-95 and either I-93 or U.S. Route 3.

Lowell

This station, the outer terminal of the Lowell Line, differs from the stations analyzed above in that it was not originally built as a regional park-and-ride facility. Instead, a

municipally-owned garage with space reserved for commuters was built next to a long-established station in 1984. (Railroad passenger service to Boston has been provided from various station sites near the present one since 1835.) The present Lowell Station is located near the center of the densely developed city of Lowell, but it is also only about one quarter mile from the end of the Lowell Connector. This limited-access highway connects Lowell with Routes I-495 and U.S. 3. These connections are made on the south side of the city, so drivers approaching the station from these highways must divert north for 1.8 miles from the route they would follow if driving on into Boston.

Lowell has a lower proportion of access by park-and-ride than most stations built as regional facilities, at 60%, and also has an unusually high kiss-and-ride rate of 25%. The majority of the latter are from Lowell itself or adjoining towns. The drawing power of Lowell Station as a regional facility is best measured in terms of park-and-ride trips alone. In the survey, 68% of park-and-ride trips boarding at Lowell Station originated in either Lowell or a directly adjoining town. This was more similar to the concentration at middle-of-line stations analyzed above than at end-of-line stations.

The largest single source of riders from a town not adjoining Lowell (and second only to Lowell itself) was Nashua, New Hampshire, with 96 (15%). Nashua has no direct rail service and no other station is closer to Nashua than Lowell. Nashua is also second only to Lowell in total population among all cities and towns with riders using Lowell Station.

Although the survey showed 17 cities and towns generating trips with park-and-ride boardings at Lowell, the top eight accounted for 94% of the total. The other nine accounted for only one to eight origins each. No city or town outside Lowell with direct rail service accounted for more than two Lowell boardings. Only 6% of Lowell park-and-ride boardings originated in towns that did not either adjoin Lowell or have continuous limited-access highway links to the Lowell Connector.

Worcester

Worcester Station is similar to Lowell Station in that both are outer terminals located in the middle of densely developed urban areas and both have regional parking facilities. Commuter rail service to Worcester was re-established in 1994 after an absence 19 years. Amtrak intercity trains had served the Worcester Station in the intervening years, but fares and schedules were not conducive to commuting.

Worcester Station is located less than one quarter mile from an interchange on Route I-290, which connects with Route I-190 to the north and with Route I-395 and the Mass. Turnpike to the south. A survey of passengers boarding at Worcester conducted in 1995, when service was less frequent than at present, showed that 81% used park-and-ride access, with most of the others using kiss-and-ride. This distribution was very similar to that at South Attleboro.

The proportion of Worcester riders with trips originating in either Worcester or an adjoining town was higher than typical of regional park-and-ride stations, at 80%. Worcester alone accounted for 49%. This was partly a result of Worcester having a much larger total population than that of any of the other cities and towns served by Worcester Station. A total of 33 cities and towns had riders using the station, but only 15 of these had more than one or two riders each, and only nine had more than five each. The latter included Worcester itself and five adjoining towns. The three non-adjoining towns contributed six or seven riders each. Only one of the three had a continuous limited-access highway connection to the station, but none had alternate public transportation service to Boston.

Kingston

Kingston Station is the outer terminal for all peak-period trains on the Plymouth / Kingston Line. It opened in September 1997 as part of the Old Colony service restoration project. (Previous passenger service on this line had ended in 1959.) Although all stations on this branch have parking facilities, Kingston is the only one with all of the characteristics of a major regional station. It is located at a driving distance of about three quarters of a mile from an interchange on state Route 3, which is one of two major limited-access highways to Boston from the South Shore and Cape Cod.

The Old Colony commuter rail survey, conducted one year after the opening of Kingston Station, found that 85% of the passengers used park-and-ride access, and that another 13% were dropped off. These percentages were very similar to those at South Attleboro, discussed above. The town of Kingston alone accounted for only 12% of the riders using the station. A total of 19 other cities and towns contributed passengers to Kingston Station. Kingston and the five immediately adjoining towns together accounted for 84% of the trip origins, with Plymouth providing the largest share (56%). Plymouth also has a station, but it is served only during off-peak hours. There are six interchanges on Route 3 within Plymouth, including one connection with a limited-access collector road. Duxbury, which was the second-largest ridership source (12.3 %), has two interchanges on Route 3.

Of 13 cities and towns originating Kingston Station boardings but not adjoining Kingston, only six contributed more than five riders each. Five of the six were on Cape Cod and were linked with Route 3 by limited-access U.S. Route 6. Most of passengers from these towns had previously made their trips by either driving or riding buses up Route 3 past the Kingston Station interchange. Marshfield, which contributed 15 riders, is north of Kingston, and is not directly on Route 3, but it adjoins Duxbury and Pembroke which both have interchanges.

Several of the cities and towns that contributed riders to Kingston Station also have private-carrier express bus service to Boston, but none are served directly by any other commuter rail line.

Middleborough/Lakeville

Middleborough/Lakeville Station is the outer terminal for all trains on the line of the same name. It opened in September 1997 as part of the Old Colony service restoration project. (Previous passenger service on this line had ended in 1959, except for a summer excursion service between Braintree and Cape Cod run in the 1980s.) Although most stations on this branch had parking facilities at the time of the survey, Middleborough/ Lakeville was the only one with all of the characteristics of a major regional station. It is located at a driving distance of about one half mile from an interchange on Interstate Route 495, which is part of one of the major limited-access highways to Boston from Cape Cod and other points in southeastern Massachusetts.

The Old Colony commuter rail survey, conducted one year after the opening of Middleborough/Lakeville Station, found that 80% of the passengers used park-and-ride access, and that another 17% were dropped off. The park-and-ride percentage was slightly lower than that at South Attleboro, discussed above, and the drop-off percentage was slightly higher. The station is directly on the border of Middleborough and Lakeville. Those two towns alone accounted for 43% of the riders. A total of 28 other cities and towns contributed passengers to Kingston Station. Middleborough and Lakeville together with eight towns that directly adjoin one or the other accounted for 69% of all the trip origins.

Of 20 cities and towns originating Middleborough/Lakeville Station boardings but not adjoining Middleborough or Lakeville, only seven contributed more than ten riders each. Of these, New Bedford was by far the most important, with 65 origins (9.4%). This included 48 work trips to Boston or Cambridge. This was equivalent to 6.6% of the number of work trips to Boston or Cambridge from New Bedford by all modes as of 1990, but the total has increased since then. There are several possible driving routes from New Bedford to Middleborough/Lakeville Station, mostly over limited-access highways.

Trip origins from the other six towns in this group ranged from 12 to 18 each, except for one (Marion) with 27. All six had good highway access to Middleborough/Lakeville Station, and the shortest driving route to Boston from four of them would have run directly past the station exit. The maximum driving access time reported from any origin was 45 minutes, and there were only four responses with this time. All other reported times were 40 minutes or less. The maximum access time for a drop-off passenger was 40 minutes.

Several of the cities and towns that contributed riders to Middleborough/Lakeville Station also have private-carrier express bus service to Boston, but none that contributed over ten riders each are served directly by any other commuter rail line.

APPENDIX G - ANALYSIS OF FURTHER EXTENSION OF COMMUTER RAIL SERVICE BEYOND I-290

The immediate proposal of the Marlborough Transportation Task Force is for an extension terminating at Route I-290 in Northborough, but statements from the Task Force indicate that the line would later be extended north to or toward Fitchburg. The mayor of Leominster has announced support for a more immediate extension at least to Leominster. The main purpose of the latter proposal is envisioned as carrying residents of Leominster to jobs in Marlborough or Framingham rather than serving travel to Boston. This appendix examines briefly some of the main considerations that would be involved in extending rail passenger service beyond I-290.

Route Description and Track Condition

North of the proposed I-290/Northborough station site, the Fitchburg Secondary Track continues in Northborough for about 1.2 miles. It then runs through Berlin, Bolton (in the extreme southwest corner only), Clinton, Lancaster, Sterling, and Leominster to a connection with the Fitchburg commuter rail line about one half mile east of Fitchburg Station. The total distance from I-290 to the Fitchburg Line is 21.0 miles, compared with 15.7 miles from Framingham Station to 1-290. Hence, a full extension would require upgrading of 2.3 times as many miles of track as an extension to I-290 only. The rehabilitation cost would be disproportionately higher on the north end of the line, however, because of a higher density of grade crossings and bridges there.

With present track condition, the maximum allowable speed limit for passenger trains between I-290 and the south end of the Leominster yard would be 30 m.p.h. From there to Fitchburg the maximum speed would be 20 m.p.h. or less. The segment between Main Street in Leominster and the Fitchburg Line connection has been out of service for several years, and may have deteriorated to a condition that would require an even lower speed.

Road Crossing Surface, Lights, and Gates

Between Colburn Street in Northborough and the junction with the Fitchburg Line in Fitchburg, the Fitchburg Secondary Track has 26 grade crossings of public roads. These are concentrated in the more densely developed areas toward the north end of the line. Of the 26 crossings, 5 are in Berlin, 1 in Bolton, 4 in Lancaster, 3 in Sterling, 10 in Leominster, and 3 in Fitchburg. (All of the public crossings in Clinton are grade-separated.) All three crossings in Fitchburg and five in Leominster are on the segment of the line that has been out of service for several years, so road users would be unaccustomed to having to wait for trains.

All but two of the active crossings are protected by automatic flashing lights, but none have gates. The other two active crossings, both in Leominster, are protected only with signs. All of the inactive crossings were formerly protected by flashing lights but not

gates. Most of the lights are probably unusable by now because of weather damage or vandalism.

In addition to the public crossings there are four private crossings in Leominster and one in Fitchburg (all on the inactive section) used by the general public. When the track was active one of these was protected by flashing lights and the other four by signs only.

Bridges

Between I-290 and Fitchburg there are seven track bridges over roads. Four of these are in Clinton, two on the active segment in Leominster, and one on the inactive segment in Leominster. There is also one track bridge over the Guilford Rail System line at Clinton Station. There are also numerous bridges and culverts over rivers and brooks, and several cattle passes at old farm sites. The longest water crossing is the 248-foot Nashua River bridge in Clinton. None of the other water bridges exceed 16 feet in length.

Route I-290 itself crosses the railroad grade on twin bridges a short distance north of the assumed I-290 / Northborough station site. North of there, the only other bridge over the rail line is at Whitney Street in Northborough.

Travel Time Comparisons from Fitchburg

At its best condition in the past, the Fitchburg Secondary was suitable for maximum passenger train speeds of 45 m.p.h. between I-290 and Fitchburg, with some additional restrictions for crossings and curves. For future passenger service, the line would need to be upgraded for top speeds of at least 60 m.p.h. Running times between Fitchburg and I-290 would depend on the number and locations of intermediate stations served. At minimum, such an extension would be likely to include one station each in Clinton, Sterling, and Leominster. This would result in a minimum running time of about 29 minutes between Fitchburg and I-290. Combined with the estimated time for a train from I-290 to Boston running non-stop from Framingham to Back Bay the total time from Fitchburg to South Station would be 85 minutes.

At present A.M. peak scheduled times for trains running via the Fitchburg Line from Fitchburg to North Station in local service range from 87 to 92 minutes, with an average of 90.3. One limited-stops train has a scheduled time of 85 minutes. or the same as the estimated minimum time via the I-290 extension. At present, the Fitchburg Line has an overall maximum speed limit of 60 m.p.h., except for an 8.4-mile section between South Acton and Willows in Ayer, where there is a 40 m.p.h. limit. In the past, the overall maximum speed limit on all sections of the line was 70 m.p.h. Express trains serving most stations between Fitchburg and South Acton and then making no intermediate stops except Concord from there to Porter Square had scheduled times of 70 minutes from Fitchburg to North Station. Restoring these past speed limits and schedules should allow a reduction of 15 minutes compared with the present fastest time from Fitchburg and the estimated minimum time via the Fitchburg Secondary Track.

Therefore, for passengers going to Boston, service via the Fitchburg Secondary would only be more attractive than that via the present route if egress time from South Station was much faster than that from North Station.

Travel Time Comparisons from Leominster

Fitchburg would be the only location at which trains running via the Fitchburg Line and via the Fitchburg Secondary would use the same station. A station in Leominster on the Fitchburg Secondary would compete for Boston traffic with North Leominster Station on the Fitchburg Line. With the same siting philosophy used on the I-290 extension, the new Leominster Station would be located near the point where the Fitchburg Secondary crosses over Route 2. The minimum running time from there to South Station would be about 80 minutes. At present, the fastest scheduled time from North Leominster to North Station is 76 minutes. The historical minimum time for an express train between these points was 64 minutes. The average access times to North Leominster and Route 2 stations from origins within Leominster would be about equal. Therefore, for passengers going to Boston a Leominster station on the Fitchburg Secondary would only be more attractive than North Leominster Station if egress time from South Station was much faster than that from North Station.

Travel Time Comparisons from Sterling and Lancaster

In Sterling, the former Pratt's Junction station site was a short distance from the present interchange of Routes 12 and I-190, making it the most logical choice for a future station in that town. The minimum running time from there to South Station would be about 72 minutes. This site is north of most of the residences in the town. The average driving time to it from within the town would be about 6 minutes, making a total travel time to South Station of 78 minutes excluding waiting time.

The 1993 survey results indicated that only about six Sterling residents used commuter rail. Boardings were distributed among North Leominster, Shirley, and South Acton, with the greatest number going to South Acton. The average reported access time to that station was 34.5 minutes. The current time for a limited-stops train from South Acton to North Station is 46 minutes, making a total travel time of 80.5 minutes from Sterling to North Station excluding waiting time. The minimum time to South Station via the Fitchburg Secondary Track would be 2.5 minutes faster than this. With restoration of historic speed limits and express service patterns, the running time from South Acton to North Station could be reduced to about 36 minutes. This would provide a total travel time of 70.5 minutes from Sterling, or 7.5 minutes less than the minimum time to South Station.

The 1990 Census found a total of only 24 Sterling residents employed in Boston Proper and none in the rest of Boston or Cambridge. It is unlikely that improved rail service either via the Fitchburg Line or via the Fitchburg Secondary would attract large numbers of riders from that town.

The next town south of Sterling on the Fitchburg Secondary Track is Lancaster. The rail line passes through only the southwest corner of the town. Historically there were never any stations on that segment of the line. There are no limited-access highways nearby. For most Lancaster residents access to a station in Clinton would be at least as convenient as access to a station within Lancaster. For these reasons, it is assumed that a future extension would not include a station in Lancaster.

Travel Time Comparisons from Clinton, Bolton, and Berlin

No limited-access highways run directly through Clinton. State Routes 62, 70, and 110 converge in the center of the town near the past station site. This would make it the most logical location for a station within the town from an access standpoint, although provision of parking could be a problem. The minimum train time from Clinton to South Station would be about 66 minutes. The average driving time to the station from points within the town would be about 4 minutes, making a total travel time to South Station of 70 minutes excluding waiting time.

In the 1993 survey results, the most common transit alternative for trips from Clinton to Boston was the Fitchburg Line via South Acton. The average reported access time to South Acton from Clinton was about 22 minutes. For passengers using the present limited-stops train, this would have resulted in a total travel time of 68 minutes to North Station, or one minute less than the estimated minimum time via the Fitchburg Secondary. Historic express train schedules on the Fitchburg Line would allow total times of 58 minutes from Clinton, or 11 minutes less than the time via the Fitchburg Secondary.

For Clinton residents, the added access time of driving to a D'Angelo Drive / I-495 station instead of a Clinton station would be slightly less than the reduction in on-train time. On average, there would be an overall saving of less than one minute from boarding at D'Angelo Drive rather than Clinton. This alone would be insufficient incentive for most Clinton residents to choose the longer access trip, but some might be attracted to D'Angelo Drive by the lower zone fare there.

Between Clinton and Berlin, the Fitchburg Secondary passes through the extreme southwest corner of Bolton for a distance of about 0.2 miles. Historically there was a Bolton Station located on the border of Clinton and Bolton where several local roads converge. There are no major highways anywhere near this site. It would be a convenient location for a small number of residents of Clinton and Bolton, but most residents of these towns would find other stations more convenient. Therefore, it is assumed that an extension to Fitchburg would not include a station in Bolton.

Between Bolton and Northborough, the Fitchburg Secondary runs through the west side of Berlin. There are no major highways nearby. Historically there were two stations on this segment. West Berlin, (also called Carter's) was 0.1 miles north of the grade crossing of the railroad with Route 62. Berlin Station was on the south side of the Jones Road grade crossing. Neither site is close to many homes or to any significant

employment areas. The West Berlin site would have better driving access from most parts of Berlin than the Berlin Station site, but would nevertheless require a large amount of doubling back for most town residents. Most of them would find either an I-290 / Northborough station or a D'Angelo Drive / I-495 station more convenient. For these reasons, it is assumed that an extension to Fitchburg would not include a station in Berlin.

Issues in Fare Structure

The present MBTA commuter rail system has fare zones based on rail distances from Boston. Most of the existing lines run generally radially out from Boston, though none follow completely straight lines. The Fitchburg Secondary Track, which was not originally intended to carry Boston traffic, has a generally south-north orientation between Northborough Center and Fitchburg. As a result, the differences among towns in rail distance from Boston are much greater than the differences in distance via direct routes would be.

The distances from South Station to Fitchburg Station and to Route 2 in Leominster via the Fitchburg Secondary Track are 58.6 and 55.4 miles. This would place both stations in Zone 10.[15] From North Station to Fitchburg via the Fitchburg Line (which is itself somewhat indirect) the distance is only 49.6 miles, and the distance to North Leominster Station is 45.3 miles. Both of these stations are in Zone 9. As detailed above, the fastest possible service to Fitchburg or Leominster via the Fitchburg Secondary would offer no line-haul time savings to Boston compared with the fastest present service on the Fitchburg Line. Therefore, there would be no justification for charging higher fares via the Fitchburg Secondary.

The distance from South Station to a potential Sterling station site on the Fitchburg Secondary is 49.7 miles, which would place it in Zone 9. Competition with the Fitchburg Line would be less direct than in Fitchburg or Leominster. Very few Sterling residents currently use commuter rail. The shortest access times are to North Leominster, in Zone 9, or Shirley, in Zone 8. Nevertheless, survey results indicate that the largest number choose South Acton in Zone 6. As detailed above, the fastest possible service to Sterling via the Fitchburg Secondary would offer little or no line-haul time savings to Boston compared with the express service from South Acton on the Fitchburg Line. Therefore, it would be difficult for a station in Sterling in Zone 9 to attract new commuter rail users.

The distance from South Station to the historical Clinton Station site via the Fitchburg Secondary is 45.0 miles, which would place it in Zone 9. In the past, the shortest rail route from Boston to this station used a combination of two Boston & Maine Railroad lines: the now-abandoned Central Mass. Branch and the still-active Worcester Route.

[15]There have never been any Zone 10 stations since the present zone system was established. The limits of Zone 10 are implied by the rail distances to present stations in Zone 9, and to the discontinued Zone 11 station in Gardner.

The distance via this routing was 38.3 miles, which would place Clinton in Zone 8. The shortest possible rail routing from Boston to Clinton Station, though never used in the past, would have involved a combination of the Central Mass. Branch to West Berlin and the Fitchburg Secondary from there to Clinton. The distance from North Station via this routing would have been 36.2 miles, which would still have placed it in Zone 8.

Using the shortest theoretical routing to Clinton and continuing to Sterling via the Fitchburg Secondary, the distance from Boston to Sterling would be 40.9 miles. This would put Sterling in Zone 8 rather than Zone 9.

The rail distance from South Station to the proposed I-290 / Northborough station site is 37.1 miles, which would place it in Zone 8. The historic Northboro Station site at the town center was 35.7 miles from South Station, which would place it just within the limit of Zone 7. If an I-290 extension included stations both at I-290 and at Northborough Center, there would be precedents for placing both stations in the fare zone applicable to the station nearer Boston, which would be Zone 7.

In summary, to compensate for the indirect routing of a commuter rail extension north of I-290 on the Fitchburg Secondary Track, there would be justification to place each station in the next-lowest fare zone than would apply on the basis of rail distance alone. There would also be some justification for reducing the fare for an I-290 station by one zone from that called for by rail mileage.

APPENDIX H - FURTHER DETAILS ON RIDERSHIP ESTIMATION METHODS

Chapter 4 of this report describes the travel markets expected to be served by an I-290 / Northborough commuter rail extension and summarizes the predicted ridership from these markets. This appendix provides further details on the methods that were used in estimating ridership.

Extension Share of Boston Proper Work-Trip Market

The share of the Boston Proper work-trip market captured by the existing commuter rail lines varies widely among the cities and towns served. These differences can be attributed to many underlying causes, but are influenced strongly by the range of options available to residents of these communities. In general, among cities and towns with direct commuter rail service, the highest rail market shares are found where average rail travel speeds are highest, highway access to Boston is poorest, no other direct transit alternatives are available, and rail access is unconstrained by parking capacity. Rail typically also attracts higher market shares as travel distance from Boston increases.

An I-290 extension would be a branch of the Framingham / Worcester Line. Trains on that line terminate at South Station and also serve Back Bay. As shown in Table 3-1, an I-290 extension with express service would provide slightly longer line-haul travel times than driving to Boston from the vicinities of most of the stations on the line, but slightly faster time from Framingham Centre. The extension would be competing for riders with the Framingham / Worcester Line and the Fitchburg Line, and to a lesser extent with several other existing transit alternatives. Furthermore, the total amount of travel to Boston from many of the towns in the extension service area is low, and is not expected to increase significantly in the next 20 years. For all of these reasons, the potential of the extension for attracting new transit riders is limited.

Based on Census and survey data for communities on existing MBTA commuter rail lines, an I-290 extension with peak-period express service and unconstrained parking could be expected to capture up to 60% of the work trips to Boston Proper from Marlborough and Northborough, up to 30% from Southborough, and up to 15% from Framingham. The 1990 Census results show a total of 360 work trips to Boston Proper from Marlborough, 120 from Northborough, 160 from Southborough and 2,055 from Framingham. Based on population projections, and on the proportions of residents going to work in Boston Proper from towns at similar distances along existing commuter rail lines, these totals are likely to top out at about 650 from Marlborough, 295 from Northborough, 335 from Southborough, and 2,470 from Framingham by 2020.

Applying the shares above would result in a total of 1,035 of these trips being captured by the extension in 2020. If the I-290 extension were not built, however, about 545 of these riders could be expected to use other mass transit facilities, so only about 490 would be new transit users.

In general, commuter rail captures smaller shares of trips from cities and towns without stations than from those with direct service, but there are exceptions. These are most likely to occur in cases where direct transportation service to Boston by modes other than rail is inconvenient but there is good access to a rail station in a nearby town. The indirect service area of an I-290 extension is discussed in detail in chapter 2. It would include 10 towns, shown on the map on page 5. Based on the relative travel times and costs using an I-290 extension or other transit alternatives for travel to Boston, the largest shares of Boston Proper work travel that the extension alone could capture from its indirect service area would be about 35% each from Berlin and Clinton, and about 25% each from Boylston, Bolton, Boylston and Lancaster. Shares from the other four towns would range from about 5% to 15%.

The 1990 Census figures show a total of 1,470 work trips to Boston Proper from the 10 indirect service towns combined. This total is likely to grow to about 2,810 by 2020. The towns in this group from which the extension would capture the largest shares of Boston Proper work trips are projected to have relatively small total levels of such travel, however. As a result the extension would serve only about 415 Boston Proper work trips per day from the 10 indirect service towns by 2020, of these about 235 would not otherwise travel by mass transit.

Extension Share of Other Boston and Cambridge Work-Trip Markets

Using procedures similar to those used for estimating Boston Proper work trips, it was concluded that an I-290 extension with peak-period express service could be expected to capture about 15% of the work trips from Marlborough or Northborough to destinations either in Boston outside Boston Proper ("other Boston") or in Cambridge. (Travel to most such destinations by commuter rail would involve a transfer to an MBTA rapid transit or bus route.) From Southborough, the extension share of these trips would be about 8%, and from Framingham it would be about 4%. The shares from the indirect service towns would range between about 1% and 9%.

The 1990 Census results show totals of 2,135 work trips to other Boston and 1,185 to Cambridge from Marlborough, Northborough, Southborough, or Framingham. From the 10 indirect-service towns, the totals were 1,290 and 890. Based on methods similar to those used in projecting growth of Boston Proper Work travel, the four direct-service municipalities would be expected to originate about 3,005 work trips to other Boston and 1,660 to Cambridge by 2020. From the indirect-service towns, the respective totals would grow to about 2,540 and 1,770.

Applying the trip-share factors above to these would result in 220 trips to other Boston and 115 to Cambridge, or a combined total of 335 from the direct-service area via the extension in 2000. The indirect service area would originate an additional 105 trips to other Boston and 75 to Cambridge, or a combined total of 180. Of the 515 trips from the entire service area, about 255 would be made by other transit alternatives if the extension were not available, and 260 would be new transit trips.

Extension Share of Other Travel Markets, Excluding Interzone and Reverse-Commuting

Boston and Cambridge Non-work Trips

As discussed in the preceding sub-sections, the manual ridership forecasting method projects that an I-290 extension would carry a total of about 1,965 inbound work trips to Boston or Cambridge from its service area in 2020. (If the extension had been in operation in the year 2000, this total would have been be about 1,550.) Based on ratios of non-work to work trips found in surveys of existing MBTA commuter rail lines, a factor of 16.7% was added to the estimates of Boston or Cambridge work trips for an I-290 extension to calculate non-work trips to these cities. This did not include return halves of reverse-commuting trips, which were calculated separately. The result was an estimate of 260 non-work trips for the year 2000, or 330 for the year 2020. About half of these would be new transit trips.

Trips to Destinations Outside Boston or Cambridge (excluding interzone)

Based on survey results, a factor of 2.3% was added to Boston and Cambridge work trips to estimate travel beyond Boston or Cambridge excluding returns of reverse-commuting trips. The result was an estimate of 35 such trips at 2000 travel levels, or 45 in 2020. All of these were assumed to be new transit trips.

Estimated Use of Extension for Interzone Travel (Excluding Reverse-Commuting)

Interzone trips on the MBTA commuter rail system are defined as those that do not either begin or end at one of the downtown Boston terminal stations or at a station in fare Zone 1A or 1B, and do not include a transfer at any of those stations. Such ridership constitutes a very small part of total patronage on the existing lines. To estimate the interzone traffic potential of an I-290 extension, characteristics of present interzone ridership were examined. A detailed analysis was then done of each of the station pairs that would be linked by the extension to determine whether the service provided would be conducive to interzone travel. The full analysis is presented below. The overall conclusion is that interzone travel would not be a significant component of ridership on an I-290 extension.

Interzone Ridership on Present MBTA Commuter Rail System in 1993 Survey

Trains serving an I-290 / Northborough extension would use the tracks of the Framingham / Worcester Line between Framingham and Boston. On that line, interzone trips are those that do not have one end point or a transfer at South Station, Back Bay, or Yawkey Station in Boston. (Yawkey Station in Zone 1A, originally only a special stop for Red Sox games, was made a general-purpose stop for selected trains in 2001.)

The 1993 commuter rail survey preceded the extension of service between Framingham and Worcester. On the route then known as the Framingham Line, interzone trips

accounted for 1.4% of all inbound rides. The only stations with any interzone boardings were Framingham, West Natick, Natick, and Wellesley. At those stations, interzone boardings ranged from 1.0% to 3.3% of all riders, with the highest percentage being at Framingham. (On all of the other South Side lines then in operation interzone ridership accounted for less than 0.9% of total boardings.) At Framingham, half of the interzone riders were destined for home, presumably on return segments of reverse-commuting trips. Therefore, only 1.6% of all riders boarding at Framingham were starting interzone trips there.

The predominant access mode for Framingham Line interzone riders was walking, at 68%. Of those walking, 84% reported access times of 10-minutes or less, (implying distances of one half mile or less) and none reported walking times longer than 20 minutes. Half of the walk-in trips began at home. Drop-offs were the second-largest access group (20%). Another 9% arrived at the boarding station by taxi and 5% by local bus. Of those that walked, only one in three had a car available for the trip. None of the interzone riders drove and parked at stations. In contrast, for all trips on the Framingham Line, 44% parked at stations, 40% walked in, and 14% were dropped off. The shortest reported interzone trip was 3.7 miles. There were no reported trips between pairs of stations in the same fare zone. An examination of interzone ticket sales from 1994 in conjunction with the survey showed that for the commuter rail system as a whole, only about 3% of all interzone tickets were sold for trips between two stations in the same fare zone.

These results imply that for interzone travel, commuter rail is attractive mostly to trip-makers who are starting from within walking distance of their boarding stations but beyond walking distance from their destinations or to others who do not have cars available for their trips.

The 1995 survey included only passengers boarding at Worcester, which was then the only station west of Framingham on the Framingham / Worcester Line. The surveyed trains also stopped at Framingham, but ran non-stop between there and Back Bay. Interzone riders going to other stations would have had to transfer to local trains at Framingham, where they would have had to wait for 10 to 15 minutes. Overall, 1.9% of all Worcester riders (6 of 322) were making interzone trips. All of them alighted at Framingham, but only one (0.3%) transferred to a local train there to complete the trip. The most common station access mode for the interzone riders (4 of 6) was being dropped off at the station. All of the drop-offs reported that they had autos available for the trip. The other two did not have autos available. One walked in, and the other arrived by bus.

Interzone Ridership on Old Colony Lines in 1998 Survey

The Old Colony commuter rail lines, which opened in 1997, have much heavier interzone ridership than the older South Side lines. A 1998 survey found that 6.3% of Old Colony riders were making interzone trips, excluding interzone riders who continued to or through Boston via rapid transit. Two thirds of the interzone riders, or

3.9% of all riders, had final destinations in the city of Quincy. Excluding return halves of reverse-commuting trips, 3.7% of Old Colony riders were destined for Quincy. There are some similarities between Quincy and Framingham as trip destinations, but there are important differences also. Figures published by the Massachusetts Division of Employment Training, (DET) show that as of 1999 there were 43,563 jobs in Framingham, compared with 47,229 in Quincy. Job locations in Quincy are more heavily concentrated within walking distance of the station, however.

All trains on the Middleborough/Lakeville branch of the Old Colony lines stop at Quincy Center. Only about half of the peak trains on the Plymouth/Kingston line stop there, but passengers on the other trains can get to Quincy by transferring to the Red Line at Braintree. Among Old Colony riders with final destinations in Quincy who alighted directly at Quincy Center, almost half (49%) completed their trips by walking. The next-largest group (39%) transferred to the Red Line, with almost all going to work locations close to North Quincy Station. The other 12% transferred to MBTA buses or employer-sponsored shuttle vans.

In Framingham, LIFT bus service could be used for distribution of commuter rail riders, but present frequencies and speeds are much lower than those provided by the connecting services in Quincy. Because of route alignment and station locations, most passengers using an I-290 extension to travel to Framingham would have to make much longer diversions from their direct driving routes then those required of Old Colony passengers going to Quincy.

The longest interzone trip to Framingham Station possible on an I-290 extension would be 15.7 miles, from I-290. A station at D'Angelo Drive in Marlborough would be 10.9 miles away. On the Old Colony lines, origins of passengers making interzone trips to Quincy were concentrated near the outer ends of the lines. About half boarded at stations more than 15.7 miles from Quincy, and over 80% boarded at stations more than 10.9 miles away.

Based on the findings above, interzone trips to Framingham Station relative to total boardings on an I-290 extension would be expected to occur at less than half of the 3.7% rate of Old Colony riders making interzone trips to Quincy.

Impact of Forced Transfers on Interzone Ridership to Points East of Framingham Station

In order to provide travel times competitive with driving, and to coordinate schedules with those of other trains on the main line, peak-period peak-direction I-290 trains would most likely run non-stop from Framingham to Back Bay. Passengers wanting to travel from new stations on the I-290 extension to intermediate main line stations would have to transfer to local trains at Framingham. For most trips, this would require waits of 10 to 15 minutes at Framingham. (For comparison, Old Colony riders who have to transfer to the Red Line at Braintree or Quincy in the A.M. peak have an average wait of three minutes.)

The Worcester survey results indicate that such a transfer would be a significant deterrent to ridership. By transferring at Framingham, Worcester riders would have had access to all of the same interzone destinations as passengers who initially boarded at Framingham. Only 0.3% of Worcester riders made such an interzone trip, compared with 1.6% of Framingham riders (excluding reverse commuters going home). The relative numbers of trips by all modes from Framingham and Worcester to destinations in Natick, Wellesley and Newton was not determined, however.

It can reasonably be assumed that the rate of interzone trip-making to points east of Framingham Station from I-290 extension stations relative to other boardings on the extension would be no more than half the ratio observed among boardings at Framingham Station. With other boardings as estimated in other sections of this appendix, this would result in a maximum combined total of 15 riders to West Natick through Newtonville, inclusive, from I-290 through Framingham Centre, inclusive. (This does not include return halves of reverse-commuting trips.)

Impact of Station Locations on Interzone Ridership Potential

Interzone trips made via I-290 trains without train-to-train transfers could theoretically take place between any station on the extension and Framingham Station or between any pair of the new stations. The 1993 survey results showed that excluding return halves of reverse-commuting trips, 86% of inbound interzone riders on South Side lines began their trips at home. Of these, only 8% drove and parked at their boarding stations. Walk-ins and drop-offs each accounted for about 39%, with small numbers of other using other access modes such as feeder buses, taxis, or bicycles.

Of the four station locations assumed for purposes of analysis, I-290 / Northborough, D'Angelo Drive / Marlborough and Route 9 & 90 in Framingham would all be in areas where land use is mostly non-residential. There are almost no homes within walking distance of D'Angelo Drive or Route 9 & 90 and very few within walking distance of I-290. Consequently the outer three stations on an I-290 extension would be lacking a significant component of the usual interzone trip sources. Most work locations served by these three stations would also be at or beyond the maximum distance that most transit users are willing to walk. Interzone trips home from work would be return halves of reverse-commuting trips. To avoid double-counting, these are included in the reverse-commuting estimates rather than in interzone totals.

A station at Framingham Centre (Salem End Road) would be the only one of the four on the extension that would be located near a large number of homes. The only inbound interzone trip possible from Framingham Centre without a transfer would be to Framingham Station. The distance between the two stations would be just under two miles either by rail or by parallel roads. The shortest interzone trip found in the Framingham Line survey was 3.7 miles, although several trips between station pairs closer together than that would have been theoretically possible. Framingham Centre and Framingham Station would both be in Zone 5. As noted above, only 3% of all

interzone trips on the commuter rail system as a whole in 1994 were made between pairs of stations in the same fare zone.

Comparisons of Interzone Train Service to D'Angelo Drive with Other Alternatives

A station at D'Angelo Drive in Marlborough would be the next-to-last station on an I-290 extension. Inbound interzone trips to there could only come from the I-290 station. Survey results show that most commuter rail interzone trips originate in the same city or town as the boarding station. This suggests that most interzone trips from I-290 would originate in Northborough. The station would be in the northeast corner of the town, forcing most passengers to double back to reach it. There are few homes within convenient walking distance of the station site, and it is unknown how many of them are occupied by people who work in the vicinity of D'Angelo Drive. Because of land use characteristics around D'Angelo Drive, interzone trips to there for purposes other than going to work would be too few to estimate.

The driving time to an I-290 station from downtown Northborough would be about five minutes. The train time from I-290 to D'Angelo Drive would be about six minutes, so total travel time from downtown Northborough to D'Angelo Drive would be 11 minutes, excluding waiting time at I-290. Upon arriving at D'Angelo Drive, most passengers would still be at least a half mile from their final destinations, requiring either long walks or transfers to some kind of connecting service.

The driving time from downtown Northborough to D'Angelo Drive would also be about 11 minutes, but most destinations in Marlborough would be even closer to Northborough than this. A trip from I-290 to D'Angelo Drive would require a two-zone interzone fare. At Fall 2000 fare levels, this would be $2.00 for a single ride or $1.55 with a monthly pass used for 21 round trips.

A passenger parking at I-290 would have to compete for parking space with passengers going to more distant points, and there would be a parking fee of a least $1.00. Most work locations in Marlborough have adequate free parking for their employees. Anyone who could drive to I-290 and park could use the same vehicle to drive to Marlborough. Most people who could have someone else drop them off at I-290 could probably arrange to be dropped off at their final destinations instead.

In a recent survey of employees at Fidelity Investments, the largest employer in the vicinity of D'Angelo Drive, 27% indicated that they would not consider using a transit service if their travel times were increased compared with driving. Another 43% indicated that they would not use a transit service that increased their travel times by over 10 minutes. From the D'Angelo Drive station to Fidelity, walking time would be about 10 minutes. A shuttle van would have a running time of about one minute, but some additional time would be required for the transfer from train to van.

In the same survey, 35% of the respondents said that they would not use a transit service with a fare of more than $1.00. Even with a pass, the train fare would average

$1.55 each way, and the parking fee at I-290 would effectively add at least another 50 cents each way. Another 41% of riders indicated that they would not pay transit fares of over $2.00 to $4.00. The rail fares would be unacceptable to some riders at the lower end of this range.

The survey indicated that about 70 Fidelity employees live anywhere in Northborough. With attitudes similar to those of their co-workers, at least 25 of these could be excluded as potential rail users on the basis of fares alone. Others would not choose rail service for reasons such as travel times or compatibility of schedules with work shifts.

Based on the likely characteristics of interzone train service relative to other alternatives, the available information on the market for such travel, and observed levels of interzone commuter rail travel on the present system, no more than about five riders per day would be expected to take trains from I-290 to D'Angelo Drive.

Comparisons of Interzone Train Service to Route 9 & 90 with Other Alternatives

A Route 9 & 90 station in Framingham would be the second stop from the outer end of an I-290 extension. Inbound interzone trips to there could come from either the I-290 station or the D'Angelo Drive station. Survey results from present lines suggest that most interzone trips from I-290 would originate in Northborough and most of those from D'Angelo Drive would originate in Marlborough.

Access considerations at I-290 are discussed in the preceding sub-section. The D'Angelo Drive station would be in the extreme southwest corner of Marlborough, and there are almost no homes within convenient walking distance of it. On-train time to Route 9 & 90 would be about 16 minutes from I-290 or about nine minutes from D'Angelo Drive. Added to access time, this would make total travel times of about 21 minutes from downtown Northborough or about 18 minutes from downtown Marlborough, excluding waiting time.

Comparisons with Driving

Driving time to the Route 9 & 90 station site would be about 22 minutes from downtown Northborough, or about 12 minutes from downtown Marlborough. Therefore, Northborough residents with final destinations right at the Route 9 & 90 station site would save an average of one minute by using the train if they arrived at I-290 immediately before departure. They would save 17 minutes of driving time, however. Marlborough residents with final destinations right at the Route 9 & 90 station site would have their total travel times increased by about six minutes by using the train if they arrived at D'Angelo Drive immediately before departure. Their driving times would be reduced by about three minutes.

Very few commuters would have destinations directly at the Route 9 & 90 station site. The largest employers in the Framingham Technology Park are over half a mile from the station, so most rail passengers would either have to take long walks or transfer to

some kind of connecting service to complete their trips. It is not necessary to go past the Route 9 & 90 station site in driving to the Framingham Technology Park from either Marlborough or Northborough. Drivers entering from the Route 30 side via New York Avenue would save even more time compared with taking the train then those entering from the Route 9 side via California Avenue.

Passengers parking at I-290 or D'Angelo Drive would have to compete for parking space with passengers going to more distant points, and there would be a parking fee of a least $1.00 at each station. Most work locations near Route 9 & 90 have adequate free parking for their employees. Anyone who could drive to a commuter rail station and park could use the same vehicle to drive to the Route 9 & 90 area. Most people from Marlborough who could have someone else drop them off at D'Angelo Drive could probably arrange to be dropped off at their final destinations instead, as the difference in driving times would be very small.

Comparisons With Present Public Transportation

At present, there is no public transportation service to the Route 9 & 90 station area from the immediate vicinities of the rail station sites in either Northborough or Marlborough. LIFT bus Route 7, which runs from the Solomon Pond Mall to downtown Framingham, can be used to travel from points in central and western Marlborough to Route 9 at California Avenue outside the entrance to the Framingham Technology Park. The scheduled running time from downtown Marlborough to California Avenue is about 18 minutes. This is longer than the driving time, because the bus does not take the most direct route and makes intermediate stops. It is the same as the estimated time to drive from downtown Marlborough to D'Angelo Drive and take a train to Route 9 & 90, excluding waiting time.

Near the outer end, LIFT Route 7 runs on Boundary Street, which forms the border between Marlborough and Northborough. Residents of Northborough could access it at several points. The driving time from downtown Northborough to the bus route at Boundary Street and U.S. Route 20 is about four minutes, or one minute less than the access time to the I-290 station site. From there to California Avenue, the bus running time is about 28 minutes, or 12 minutes longer than the train time from I-290 to Route 9 & 90 would be, so the train would save a net of 11 minutes. Like the train, the LIFT bus would leave most passengers beyond convenient walking distance of destinations in the Framingham Technology Park.

A train trip from I-290 to Route 9 & 90 would require a three-zone interzone fare. At Fall 2000 fare levels, this would be $2.50 for a single ride or $1.95 with a monthly pass used for 21 round trips. A trip from D'Angelo Drive to Route 9 & 90 would require a two-zone interzone fare. This would be $2.00 for a single ride or $1.55 with a monthly pass used for 21 round trips. The current LIFT bus fare is $1.50 one way, or 90 cents using a 20-ride pass, regardless of distance traveled.

Framingham Technology Park Survey Results

A 1998-99 survey of employees of three of the largest employers in the Framingham Technology Park included a total of 31 responses from workers living in Northborough and 70 from Marlborough residents. This survey did not include questions about attitudes toward transit times and fares. Assuming that these employees had views similar to those discussed above for destinations at D'Angelo Drive, train travel times would be unacceptable to at least 25% of the potential interzone riders to Route 9 &90 and fares would be unacceptable to at least 33%. Those that did not reject train service on the grounds of travel times or fares would not necessarily find it suitable in all other respects.

Conclusions

Based on the likely characteristics of interzone train service relative to other alternatives, the available information on the market for such travel, and observed levels of interzone commuter rail travel on the present system, neither I-290 nor D'Angelo Drive would be expected to attract more than about five riders per day going to Route 9 & 90.

Comparisons of Interzone Train Service to Framingham Centre with Other Alternatives

Development in the vicinity of the Framingham Centre station site includes a mix of single-family homes, small businesses, and the Framingham State College Campus. There are no large office parks comparable to those around D'Angelo Drive and Routes 9 & 90. The Framingham Centre station would be the third from the outer end of the line, so interzone riders going there could board at I-290, D'Angelo Drive, or Route 9 & 90.

Access considerations at the outer two stations are discussed in the preceding subsections. Present development within walking distance of the Route 9 & 90 station site is almost entirely non-residential. There is a hotel immediately adjoining the station site, but hotel guests would have little reason to travel to Framingham Centre. The rail distance from Route 9 & 90 to Framingham Centre is 2.3 miles. This is less than the minimum distance for which the existing commuter rail system has been found to be used for interzone travel. Because of their distances from Boston, the two stations would be in different fare zones.

Comparisons with Driving

On-train time to Framingham Centre would be about 20 minutes from I-290 or about 13 minutes from D'Angelo Drive. Added to access time, this would make total travel times of about 25 minutes from downtown Northborough or about 22 minutes from downtown Marlborough, excluding waiting time. Train time from Route 9 & 90 to Framingham Centre would be about four minutes. Access time to Route 9 & 90 is

difficult to calculate because it is unclear what residential origins within Framingham this station would serve.

Driving time to the Framingham Centre station site would be about 27 minutes from downtown Northborough, about 17 minutes from downtown Marlborough, and about five minutes from the vicinity of Route 9 & 90. Therefore, Northborough residents with final destinations right at the Framingham Centre site would save an average of two minutes by using the train if they arrived at I-290 immediately before departure. They would save 22 minutes of driving time, however. Marlborough residents with final destinations right at the Route 9 & 90 station site would have their total travel times increased by about five minutes by using the train if they arrived at D'Angelo Drive immediately before departure. Their driving times would be reduced by about eight minutes. Passengers traveling between the immediate vicinities of the Route 9 & 90 and Framingham Centre stations would save about one minute using the train, excluding waiting time.

Framingham State College is the largest individual trip attraction point that would be served by a Framingham Centre station. The station would be on the west edge of the campus. For most passengers going to the college, the walking distance from the station would be about the same as the distance from the parking lot they would use if they drove. Information on the number of faculty and students residing in Northborough and Marlborough was not available for this study. In any case, graduations and new enrollments would result in substantial year-to-year changes in the addresses of the student population.

At the outer trip end, most passengers would drive or be dropped off, as there are few homes within walking distance of any of the stations west of Framingham Centre. Anyone driving and parking would have the same vehicle available to drive for the entire trip. Passengers parking at any station would have to compete for parking space with passengers going to more distant points, and there would be a parking fee of at least $1.00 at each station. Framingham State has several free parking lots. For students on limited budgets, cost alone would be a major deterrent to riding commuter rail instead of driving if the latter was an option. (Commuter rail fares are discussed in the next subsection)

Comparisons With Present Public Transportation

Bus service between the general vicinities of the Route 9 & 90 and Framingham Centre stations is currently provided by LIFT Bus Route 7. The scheduled time between the stops nearest the station sites is about nine minutes. The train time between the same points would be about four minutes, but the bus stops are closer to more origins and destinations than the rail stations would be. Train travel between these stations would require a two-zone interzone fare. This would be $2.00 for a single ride or $1.55 with a monthly pass used for 21 round trips. The current bus fare is $1.50 one way, or 90 cents using a 20-ride pass.

At present, there is no public transportation service to the Framingham Centre station area from the immediate vicinities of the rail station sites in either Northborough or Marlborough. LIFT bus Route 7 provides service directly to the Framingham State campus from points in central and western Marlborough and the eastern border of Northborough. From downtown Marlborough to Framingham State, the scheduled running time is 33 minutes. From U.S. Route 20 at the Northborough town line, the scheduled time is about 43 minutes. Driving access time to this stop from downtown Northborough would add about four minutes.

A trip from I-290 to Framingham Centre would require a four-zone interzone fare. At Fall 2000 fare levels, this would be $2.75 for a single ride or $2.14 with a monthly pass used for 21 round trips. A trip from D'Angelo Drive to Framingham Centre would require a three-zone interzone fare. This would be $2.50 for a single ride or $1.95 with a monthly pass used for 21 round trips.

The current LIFT bus fare to Framingham Centre is the same from all stops in Marlborough as it is from within Framingham, that is $1.50 one way, or 90 cents using a 20-ride pass. The LIFT bus times are much slower than the present driving times or the projected travel times by train. For students without cars available for the entire trip, the bus fares would be much more attractive then the train fares, however.

Comparisons With Interzone Ridership to Other College Campuses

At other suburban college campuses adjoining commuter rail stations, ridership has been found to consist predominantly of reverse-commuters from Boston rather then interzone riders from further out on the lines. A 1998 passenger count at Bridgewater Station, adjoining Bridgewater State College on the Old Colony Middleborough/Lakeville Line, found only three inbound alightings and four outbound boardings for any purpose all day. There were 26 outbound alightings in the A.M. peak alone, mostly by students. The only station further out on the line is Middleborough/Lakeville, which is 7.9 miles away. This is slightly less than the distance from D'Angelo Drive to Framingham Centre.

A 1994 passenger count at Brandeis/Roberts Station on the Fitchburg Line in Waltham, adjoining Brandeis University, found a total of eight passengers alighting from four inbound A.M. peak trains and proceeding in the direction of the University. In the same time span, 94 passengers alighted from outbound trains and proceeded toward the campus. On this line there are 12 stations further from Boston, at distances ranging from 1.7 to 38 miles from Brandeis/Roberts. The boarding stations of the eight inbound alighting passengers were not determined. Survey results showed that for overall daily Brandeis inbound alightings, the shortest rail distance traveled was 5.2 miles. For 56% of the riders rail distance exceeded that to Framingham Centre from D'Angelo Drive, and for 24% it exceeded the distance to Framingham Centre from I-290. Overall, 55% of these riders walked to their boarding stations, 29% were dropped off, and 16% drove and parked at stations. These figures differ significantly from the 33% walk-ins, 15% drop-offs, and 49% park-and-rides reported for the line as a whole. There was no

alternate public transportation to Brandeis from points further out on the line at the time of the count and survey (and there is still none).

Conclusions

Based on the likely characteristics of interzone train service relative to other alternatives, the available information on the market for such travel, and observed levels of interzone commuter rail travel on the present system, neither I-290 nor D'Angelo Drive would be expected to attract more than about five riders per day going to Framingham Centre. A Route 9 & 90 station would not be expected to originate any riders for Framingham Centre.

Comparisons of Interzone Train Service to Framingham Station with Other Alternatives

Framingham Station would most likely be the innermost point to which interzone trips could be made from an I-290 extension without transferring between trains. Trips ending there could theoretically begin at any of the four extension stations. Information on present travel modes to final destinations in downtown Framingham is unavailable. Based on the present alternatives and on distances, it would be expected that most trips from Northborough or Marlborough would be made by driving, with small numbers using LIFT buses. From the vicinity of Route 9 & 90 the travel mix would include being dropped off, and from Framingham Centre it could also include a few walking trips.

Travel from Northborough

In the 1993 survey, for passengers driving to Framingham Station from Northborough the reported average access time was about 26 minutes. Framingham Station is centrally located within the downtown area, so the average driving time to final downtown destinations would be about the same as this. Train running time from the I-290 / Northborough station would be about 25 minutes. In addition to this, Northborough residents would have an average five-minute access drive to the station. Therefore, excluding waiting time at the station, train service would increase travel time by four minutes compared with driving. A trip from I-290 to Framingham Station would require a four-zone interzone fare. At Fall 2000 fare levels, this would be $2.75 for a single ride or $2.14 with a monthly pass used for 21 round trips.

To travel to downtown Framingham by bus from Northborough currently requires going to the border of Marlborough to board LIFT Bus Route 7. From Route 20 at the town line, the scheduled bus time to downtown Framingham is about 50 minutes. Driving access time to the bus from downtown would add another four minutes, and there would be some additional waiting time. Train service would be substantially faster than the present bus service, but it is doubtful that the bus service attracts many riders. (The bus route has been running only since the Spring of 2000 and detailed ridership figures are not available.) The bus would offer substantial savings in fares compared with a train, at $1.50 for a single ride or 90 cents with a 20-ride pass.

Travel from Marlborough

In the 1993 survey, for passengers driving to Framingham Station from Marlborough the reported average access time was about 22 minutes and average driving time to final downtown Framingham destinations would be about the same as this. Train running time from the D'Angelo Drive station would be about 18 minutes. In addition to this, Marlborough residents would have an average 10-minute access drive to the station. Therefore, excluding waiting time at the station, train service would increase travel time by six minutes compared with driving. A trip from D'Angelo Drive to Framingham Station would require a three-zone interzone fare. At Fall 2000 fare levels, this would be $2.50 for a single ride or $1.95 with a monthly pass used for 21 round trips.

LIFT Bus Route 7 currently provides service to downtown Framingham from points in central and western Marlborough. From the city center, the scheduled bus time to downtown Framingham is 40 minutes. Train service would be faster than the present bus service, but the bus would offer substantial savings in fares compared with a train, at $1.50 for a single ride or 90 cents with a 20-ride pass. (The bus route has been running in its present configuration since the Spring of 2000 and detailed ridership figures are not available.)

Travel from Route 9 & 90 Area

The driving time to downtown Framingham from Route 9 at California Avenue is about 11 minutes. The running time for a train from a Route 9 & 90 station to Framingham Station would be about eight minutes, but most passengers would have some access time in addition to this. Excluding waiting time, train service would save at most three minutes compared with driving. A trip from Route 9 & 90 to Framingham Station would require a two-zone interzone fare. At Fall 2000 fare levels, this would be $2.00 for a single ride or $1.55 with a monthly pass used for 21 round trips.

LIFT Bus Route 7 currently provides service to downtown Framingham from points in the same town along the west end of Route 9. From California Avenue, the scheduled bus time to downtown Framingham is about 23 minutes. Train service would be faster than the present bus service, but the bus would offer lower fares, at $1.50 for a single ride or 90 cents with a 20-ride pass. Most of the residential development along Route 9 is further east than California Avenue. From most of the Edgewater apartment complex, access time would be shorter to Framingham Centre than to Route 9 & 90. From Framingham Centre, train time to Framingham Station would be faster and the fare would be lower.

Travel from Framingham Centre

The driving time to downtown Framingham from Route 9 at Framingham Centre is about six minutes. Train time from a Framingham Centre station to Framingham

Station would be about four minutes. Excluding access, egress, and waiting time, train service would save two minutes compared with driving.

At present, Framingham LIFT Bus Route 7 provides hourly service between Framingham Centre and downtown Framingham. The scheduled running time between the stops nearest the commuter rail station locations is eight minutes, but the bus provides direct service to more downtown locations. Under the Fall 2000 fare structure, the train fare from Framingham Centre to Framingham Station would be $1.75 for a single ride or $1.33 for a passenger using a monthly pass for 42 round trips. The present LIFT bus fare is $1.50 for a single ride or 90 cents per trip using a 20-ride ticket.

The main advantage of train service would be greater frequency. Under the schedule assumed for purposes of analysis, train service would include five inbound A.M. peak trips and five outbound P.M. peak trips, compared with three LIFT trips each in the same intervals. Scheduling constraints would not permit the trains to run on uniform headways, however, so the added frequency would not necessarily result in added convenience for many local Framingham trips.

Conclusions

In conclusion, use of I-290 extension trains for interzone travel to downtown Framingham would increase travel times compared with driving from most origins in Northborough and Marlborough and would at best reduce travel time slightly from origins in Framingham. Train service would be faster then present bus service from most points, but would also charge significantly higher fares. The number of passengers making interzone trips to Framingham Station from points further out on the line would be small, probably not exceeding 5 to 10 riders per day from each boarding station, or a total of about 30 from all four stations combined.

Summary

The service provided by trains originating on an I-290 / Northborough commuter rail extension would not attract significant levels of interzone travel (that is trips entirely outside of Boston). There are many reasons for this. The locations of the extension stations would require that most interzone passengers drive to their boarding stations and transfer to connecting shuttle services or take long walks to get from their alighting stations to their final destinations. Potential riders with cars available would have little incentive to drive to stations and take trains instead of driving all the way to their destinations. For those unwilling or unable to drive the entire distance, there is currently bus service available between most of the origin-destination pairs that would be linked by interzone commuter rail trips entirely on the extension. Although the bus service is slower than train service would be, the bus fares are also much lower. For those without cars, transit fares would be expected to be an important consideration.

Passengers traveling from I-290 extension stations to all or most intermediate points between Framingham Station and Boston would have to transfer to local trains at Framingham. The added time and inconvenience of such transfers would be a significant deterrent to such travel, which would be relatively small even if direct service were available.

Estimated Use of Extension for Reverse Commuting

General Considerations Affecting Demand

On an I-290 extension, reverse-commuters would travel from home to work or school on outbound (away from Boston) trains and would return home on inbound trains. To attract such trips, the extension would have to provide convenient and economical transportation to work locations or schools in the extension area from Boston or intermediate points.

Because of operating constraints described in other chapters, it is most likely that between Back Bay and Framingham reverse-commuting trains would make intermediate stops at most at one station in Wellesley and one in Natick. Few passengers would be willing to walk more than one mile to access one of these stations. Reverse commuters driving and parking at stations would have to compete with Boston-bound riders for parking spaces and would have to pay to park. In contrast, there is ample free parking for workers at the major employment sites along the I-290 extension route. South Station and Back Bay are within walking distance of much larger populations than are the stations in Wellesley and Natick. The Boston stations also have extensive feeder service connections. For all of these reasons, demand for reverse-commuting service would come predominantly from Boston.

Passengers could include some commuters who would otherwise have made the same trips by other means, and some who would not have made these trips in the absence of rail service. Those diverted from other means of travel would be expected to be in the majority, as new public transportation service alone usually provides insufficient incentive for large numbers of people to change work, school, or home locations. For example, the survey of passengers on the Old Colony commuter rail lines one year after the start of service found that 81% were making trips that they had formerly made by some other means. Of the remaining 19%, some undetermined proportion had coincidental changes in their travel needs after the Old Colony service startup and would have found other means of making their trips if Old Colony service had not been operating.

Size of Reverse-commuting Market

Information on present reverse commuting susceptible to diversion to an I-290 extension is limited. The most recent available Census Journey-to-Work figures are from 1990. At that time, work locations in the areas that would be served most directly by an I-290 extension attracted only small percentages of their total workers from

Boston, and even smaller percentages of employed Boston residents worked in areas along the extension. By far the most work locations of Boston residents were in Boston itself, at 62%. Such work sites were about equally distributed between Boston Proper and other parts of the city.

According to the Census figures, the town of Framingham was the work location of 1,084 Boston residents in 1990. Based on employment figures published by the Massachusetts Division of Employment Training, (DET), this was equal to 2.8% of all workers employed in Framingham, and to 0.4% of Boston residents employed anywhere. Of the Boston residents working in Framingham, only 285 (26%) worked in Census tracts that included Framingham Centre and the industrial and office parks around the interchange of Routes 9 and 90.

In 1990, a total of 556 Boston residents were reported working in Marlborough. This was equal to 2.7% of all workers employed in Marlborough, and to 0.2% of Boston residents employed anywhere. Of the Boston residents working in Marlborough, 378 (68%) worked in Census tracts in the western half of the city, bordering on I-495.

In 1990 only 67 Boston residents worked in all of Southborough. This was equal to 1.6% of all workers employed in Southborough, and to 0.02% of Boston residents employed anywhere. That year only 34 Boston residents worked in all of Northborough. This was equal to 0.6% of all workers employed in Northborough, and to 0.01% of Boston residents employed anywhere.

The combined total of 764 Boston residents working in Northborough, Southborough, and areas of Marlborough and Framingham nearest the I-290 extension route in 1990 was equal to 0.27% of all Boston residents who were then employed anywhere. Of these, 276 (36%) were from homes in Boston Proper and 488 from outlying neighborhoods. In Boston, reverse-commuting trains to I-290 would stop only at South Station and Back Bay. Many, but not all Boston Proper residents would be able to access one of these stations by walking. Most residents of outlying neighborhoods would require transportation to South Station or Back Bay. This would reduce the perceived convenience of train service compared with driving for the entire trip.

Some companies that were located in the I-290 extension corridor in 1990 have relocated or closed since then. There has also been a substantial amount of new office park development in the corridor. Between 1990 and 1999 (the most recent year for which figures are available) total employment at work locations in Northborough, Marlborough, Southborough, and Framingham combined grew by 17.8%. During that time, transportation links useful for reverse-commuting from Boston did not change significantly. Between 1990 and 2000, total Boston population increased by 2.6%, but the number of Boston residents in the labor force decreased by 4.1%. The unemployment rate among Boston residents fell from 5.7% to 2.9%. Total employment at work locations within the city of Boston grew by 6.9% between 1990 and 1999, and total employment at work locations in cities and towns immediately adjoining Boston grew by 9.3%. Overall, these changes would not be expected to have resulted in a large

increase in the absolute number of Boston residents working in the I-290 extension corridor between 1990 and 2000.

Marlborough Survey Results

During 1999 and 2000, several employers in Marlborough participated in an employee transportation survey conducted by the Marlborough Transportation Management Association in cooperation with the I-495 Corridor Commission. Although the results of this survey do not provide a complete picture of reverse commuting, they do provide an indication of the distribution of origins of workers in Marlborough and of their attitudes toward public transportation.

Origins and Destinations

DET figures show that in 1999 there were 1,301 employers in Marlborough, providing 26,900 jobs. The majority of these were small businesses, as the average number of workers per employer was 20.7. The number of Marlborough residents employed anywhere was 19,369. Hence, at least 7,531 jobs in Marlborough (28%) were held by residents of other cities and towns. The actual number of commuters to Marlborough would have been much larger, as many Marlborough residents worked elsewhere.

Transportation survey results were returned by 11 employers, or 0.8% of the total in the city. Together, these companies employed about 5,200 workers, or about 19% of the total employment in the city, however. Surveys were completed by 3,316 workers, or 12.3% of all those employed in Marlborough. Most of the companies participating in the survey had employment levels substantially higher than the city-wide average. Large companies would be likely to attract workers from a wider geographic area than would small businesses. Therefore, it is probable that the percentage of non-resident workers in the survey was much higher than that for Marlborough jobs as a whole.

The largest employer participating in the survey was Fidelity Investments. With 3,500 employees in Marlborough, Fidelity alone accounted for 13% of all jobs in that city. Of the Fidelity employees completing the survey, 5.6% reported addresses in the city of Boston, implying that about 200 workers a day commute from Boston to Fidelity's Marlborough offices. Fidelity is headquartered in Boston, and many of the workers at the Marlborough location were transferred there recently from the Boston offices. Therefore, the proportion of surveyed Fidelity employees with home addresses in or near Boston would be expected to be larger not only than those for other Marlborough employers but also larger than Fidelity itself would have in the long range.

Of the other 10 Marlborough employers participating in the survey, nine returned results including home addresses. Seven of these had no responses with Boston addresses, and the other two had responses from only eight Boston residents. For the nine companies combined, only 0.8% of employees were Boston residents. Applying this percentage to total Marlborough employment excluding Fidelity would result in an estimate of 200 workers from Boston in addition to the 200 at Fidelity. The total

estimate of 400 would represent a decrease of 156, or 28% from the 1990 Census figure. Furthermore, as discussed above, small businesses not included in the survey would be expected to be less likely to attract workers from Boston than the employers that were included.

Total employment in Marlborough grew by 31% between 1990 and 1999, but in the same span manufacturing jobs alone decreased by about 20%. Manufacturing would have been one of the more likely sectors to attract workers from Boston in 1990, so a net decrease in employment of Boston residents in Marlborough would be consistent with a drop in total manufacturing jobs.

The employers participating in the survey had various locations throughout the city of Marlborough. The route of an I-290 extension passes through Marlborough in only two short segments near the southern border. The most likely location for a station would be at D'Angelo Drive. Of the employers participating in the survey, Fidelity was nearest to the station, but was about one half mile away, uphill, on a route that currently has no sidewalks. At present, almost all of the Fidelity employees drive and park on-site in a free lot. Access from the rail station would be considerably less convenient even if a shuttle service were provided.

The second-largest Marlborough employer participating in the survey was Bell Atlantic, with 600 employees in a building on Locke Drive. This site is about three miles from the D'Angelo Drive station site, so all rail users would require connecting service.

Starting and Ending Times of Work Shifts

The survey results show that Fidelity employees have a variety of starting times for their workdays. The largest percentage starting work in any half-hour interval was 39.6% between 8:00 and 8:30 A.M., followed by 21.3% between 7:30 and 8:00. With the available time slots on the main line and projected running times, a train allowing an arrival at Fidelity between 8:00 and 8:30 A.M. would be the most costly trip to provide, as it would be unable to use the same equipment as any inbound A.M. peak train. The least costly trip to provide would be one arriving between 8:30 and 9:00, but only 15% of Fidelity workers had starting times in that interval.

Fidelity workers likewise had a variety of ending times for their workdays. The most common half-hour interval was 5:00 to 5:30, reported by 31.0%, followed closely by 5:30 to 6:00 at 28.7%. Another 19.7% left between 6:00 and 7:00. Only 7.7% reported departure times between 4:30 and 5:00, and only 5.9% departed before 4:30. With the constraints imposed by expected schedules of Worcester trains, and allowing for four outbound P.M. peak trips to I-290, available departure times for inbound reverse commuter trains at D'Angelo Drive would be limited to approximately 4:30, 5:05, 5:30, and 6:10. A 4:30 departure would be too early for most Fidelity workers. Allowing for time to get from the Fidelity site to the station, a 5:05 departure would also be too early for many of those leaving in the peak half hour of 5:00 to 5:30, but some unable to make a 5:05 train would find the wait until 5:30 too long. Likewise, for those leaving work in

the second most common time of 5:30 to 6:00, a 5:30 departure would be too early, but the wait for a 6:10 departure would be too long for some.

Reverse-commuters with other work locations would not all have the same arrival and departure time requirements as Fidelity employees. The most common work starting time at Bell Atlantic was between 7:00 and 7:30 A.M., reported by 25.2%, followed by 8:00 to 8:30, at 21.8%. The latter is the same as the peak time reported at Fidelity, which as noted above would be the most costly to serve. _In contrast, only 13.1% of Fidelity employees had starting times between 7:00 and 7:30.

The most common time for Bell Atlantic employees to leave work was 4:00 to 4:30 p.m. (25.2%) followed by 4:30 to 5:00 (20.6%). Another 21.8% finished work earlier than 4:00. In contrast, only 13.6% of Fidelity employees finished work before 5:00.

From these results, it is clear that reverse-commuting service would have to offer several morning arrival times and several evening departure times in order to be usable by more than a small percentage of those employed in the I-290 extension service area. Train frequency would be only one of many attributes considered by commuters in deciding whether to use the service, however.

Importance of Travel Time

In the survey, 27.4% of Fidelity employees said that they would only use a transit service that took no longer than their current driving times, and another 42.5% said that a transit service would have to take no more than 10 minutes longer than driving. Among Bell Atlantic employees the results were similar, with 32.8% unwilling to use a transit service that would take any longer than driving and another 31.2 % unwilling to use a service taking more than 10 minutes longer than driving.

Using the new I-495 interchange that recently opened in Marlborough, the typical A.M. peak driving time from South Station in Boston to the D'Angelo Drive station site will be about 45 minutes. The fastest time estimated for a limited-stops reverse-commuting train between the same two points is 55 minutes. Few commuters would have either or both trip end directly at a commuter rail station, so additional time would be required to get from home to boarding station and from alighting station to work location. Most drivers would also require time to get from home to a main highway at the inner end. In Marlborough, the new driving route from I-495 to Fidelity will be slightly shorter than that to D'Angelo Drive. Commuters going to Bell Atlantic would still stay on I-495 to Route 20, beyond the new interchange. Overall travel times would vary by individual, but it is reasonable to conclude that for most reverse commuters from Boston, rail service to Marlborough would take more than 10 minutes longer than driving the entire distance. About 70% of Fidelity employees and 64% of Bell Atlantic employees indicated that they would not use such a service, without even taking other attributes into consideration.

Importance of Fares

Another survey question pertained to the level of fares that commuters would be willing to pay for transit service. Overall, 34.5% of Fidelity employees and 31.4% of Bell Atlantic employees indicated that they would not use a service with a fare of more than $1.00. Another 41.2% from each company indicated that they would not use transit service with a fare of more than $2.00 to $4.00. On an I-290 extension, a station in Marlborough would most likely be in commuter rail fare Zone 7. As of Fall 2000, fares from Boston to a Zone 7 station would range from $3.64 for a monthly pass user making 21 round trips to $4.50 for a single ride. The former would be close to the maximum that the majority of Fidelity and Bell Atlantic workers indicated that they would be willing to pay, and the latter would exceed that maximum. It should be noted, however, that the survey results did not separate these responses by point of origin. Commuters with longer trips, such as from Boston, would be expected to be willing to pay higher fares than those from origins closer to Marlborough.

Importance of Number of Transfers Required

Another service attribute very important to survey respondents was the number of transfers involved in making the trip. Only 11.7% of Fidelity employees and 10.4% of Bell Atlantic employees indicated a willingness to use a transit service requiring more than one transfer between vehicles. As discussed above, the Fidelity and Bell Atlantic sites are about one half mile and three miles from the D'Angelo Drive station site. Bell Atlantic would definitely need connecting service, and many Fidelity employees would also want connecting service. Commuters unwilling to make more than one transfer would therefore not use the service if their trip origins were beyond walking distance from the initial rail boarding station. This implies that few Boston residents with homes outside Boston Proper could be attracted. Again, however, the survey results did not separate responses by origin points, so it cannot be determined if Boston residents had above-average willingness to make multiple transfers.

Framingham Technology Park Survey Results

During 1998 and 1999, several employers in the Framingham Technology Park participated in an employee transportation survey similar to the later Marlborough survey, but with fewer questions about attitudes toward mass transit. The results provide an indication of the distribution of origins of workers in the area near where a Route 9 & 90 station would be located on an I-290 extension, and of their work schedules.

Origins and Destinations

DET figures show that in 1999 there were 2,263 employers in Framingham, providing 43,563 jobs. As in Marlborough, the majority of these were small businesses. The average number of workers per Framingham employer was 19.3. The number of Framingham residents employed anywhere was 37,370. Hence, at least 6,193 jobs in

Framingham (14%) were held by residents of other cities and towns. The actual number would have been much larger, as many Framingham residents worked elsewhere.

Transportation survey results were returned by three employers, providing 5.6% of the total jobs in the town. Surveys were completed by 1,788 workers, or 4.1% of all those employed in Framingham. The companies participating in the survey had employment levels substantially higher than the city-wide average. Large companies would be likely to attract workers from a wider geographic area than would small businesses. Therefore, it is probable that the percentage of non-resident workers in the survey was much higher than that for Framingham jobs as a whole.

Employees of Bose Corporation returned the largest number of surveys, with 875. Of these, 22 (2.5%) were from Boston residents, including five with addresses in Boston Proper and 17 from outlying neighborhoods. Employees of the Genzyme Corporation returned the second-largest number of surveys, with 538. Of these, 19 (3.5%) were from Boston residents, including seven with addresses in Boston Proper and 12 from outlying neighborhoods. Employees of the Staples Corporation corporate offices returned 375 surveys. Of these 18 (4.8%) were from Boston residents, including ten with addresses in Boston Proper and eight from outlying neighborhoods. The three companies had responses from a combined total of 59 Boston residents, including 22 from Boston Proper. Only the latter would be able to access South Station or Back Bay by walking if they were to take I-290 extension trains to work. Expanding the survey responses to the total number of Framingham employees of these companies would result in a combined total of about 90 Boston residents, including 34 from Boston Proper.

Applying the average percent of employees from Boston at the three companies in the survey to total 1999 employment in Framingham would result in an estimate of 1,435 as the number of Boston residents employed anywhere in Framingham in 1999. This would be an increase of 32.8% from 1990, compared with a gain of only 11.6% in total Framingham employment in the same span.

Staples and Genzyme both have work locations in Boston as well as in Framingham, and some of the Framingham employees may have transferred there recently. The Bose Corporation has been located at the Framingham site for many years, and does not have a Boston location. The smaller percentage of Boston residents among Bose employees compared with those of the other two companies is consistent with this.

In the 1990 Census Journey-to-Work reports, a total of 112 Boston residents were employed at sites in Tract 3840, which includes the Framingham Technology Park. Of these, 30 were residents of Boston Proper and 82 were from outlying neighborhoods. DET figures do not show changes in employment in individual Census tracts between 1990 and 1999. Since the survey results came from only three of the many employers in Tract 3840, the figures suggest that the total number of Boston workers in the tract has increased since 1990. Nevertheless, because of the small base number, even a disproportionately large percentage gain would have resulted in a fairly small absolute total.

Starting and Ending Times of Work Shifts

Employees of companies in the Framingham Technology Park, like those of companies in Marlborough, have a variety of starting and ending times for their work days. For all three Framingham companies surveyed, the most common starting time was between 8:00 and 8:30 A.M. At Staples, 46.4% started in this interval, compared with 42.4% at Bose and 32.9% at Genzyme. With the available time slots on the main line and projected running times, workers needing to arrive at sites in the Framingham Technology Park between 8:00 and 8:30 A.M. would have to use a train that would arrive at the Route 9 & 90 station at 7:55 A.M. This would be the same train used by the greatest number of workers going to Fidelity in Marlborough. As stated above, this would be the most costly of all reverse-commuting trips to provide.

The least costly trip to run would be one arriving at Route 9 & 90 at about 8:30. This would be suitable for work shifts starting between 8:30 and 9:00, but only about 9% of employees at either Bose or Staples started in that interval. At Genzyme, 23.1% of workers had shifts starting then.

The most common ending time for workers at all three Framingham companies was 5:00 to 5:30, reported by 46.4% at Staples, 30.4% at Bose, and 26.5% at Genzyme. With the time constraints imposed by outbound trains on both the main line and the I-290 extension, inbound reverse-commuting service would be likely to include departures from Route 9 & 90 at about 5:15 and 5:40. Most workers with shifts ending between 5:00 and 5:30 would be able to use one of these trips, but some finishing right at 5:30 might have difficulty getting to the station by 5:40. After that, the next feasible departure time would not be until around 6:20.

The second most common ending time at all three Framingham companies was between 5:30 and 6:00, reported by 23.5% at Staples, 22.4% at Bose, and 23.9% at Genzyme. A train departing at 6:20 would be suitable for workers actually finishing at 6:00. For those finishing closer to 5:30 but not soon enough to take a 5:40 train, a 6:20 departure would require an excessive wait.

Attitudes Toward Mass Transit

The Framingham surveys did not include the questions on travel times, transfers, and fares that were asked in the Marlborough surveys, but questions that were included did not show strong support for mass transit. Among workers who currently drive alone, 34% to 39% at each of the companies indicated that they would not consider mass transit as an alternative. Another 22% to 26% indicated that mass transit would be their last choice after carpooling or vanpooling if they could not drive alone. Between 65% and 69% at each of the companies indicated that offering a discount on a transit pass would not be likely to induce them to switch to mass transit. Between 34% and 44% indicated that they drove alone because they preferred to do so and enjoyed their privacy.

Between 41% and 44% of respondents at each Framingham company indicated that overall travel time from home to work was one of their most important concerns about their commute. In most cases, mass transit would increase overall travel time. For those already concerned with travel time, this would make mass transit less attractive than continuing to drive. In addition, some of those not concerned about overall travel time when driving would nevertheless find the increased time via mass transit unacceptable. Highway congestion was listed as a concern by 55% of Bose workers, but by only 33% to 38% of Genzyme and Staples workers. Bose had the smallest percentage of workers residing in Boston of the three companies, however. Relatively few workers at any of the companies found their present commuting frustrating, ranging from 19% at Staples to 27% at Bose.

It should be noted that as with the case of the Marlborough surveys, attitudinal responses were not separated by home town. It is possible, therefore, that workers residing in Boston had more positive opinions of mass transit than respondents in general.

Use of Existing Framingham/Worcester Line for Reverse Commuting

The Spring 2001 schedule on the Framingham / Worcester Line included three outbound trains that would allow reverse commuting to jobs with common starting times in or near downtown Framingham. Train 503 left Boston at 6:50 A.M., and ran non-stop from Back Bay to Framingham Station, where it was due at 7:25. This was a new Worcester train added on April 30, 2001. The other two trains were well-established. Train 505 left Boston at 7:00 A.M., arriving at Framingham Station at 7:40. Train 507 left Boston at 7:35, arriving at Framingham Station at 8:17. Both of these trains ran non-stop from Back Bay to Wellesley Hills, and then stopped at all stations to Framingham, where they terminated.

Inbound P.M. peak service in Spring 2001 included departures from Framingham at 3:45, 5:40, 6:11, and 6:30 P.M., arriving in Boston at 4:32, 6:27, 6:57, and 7:15. Three of these were well established trains originating at Framingham, but the 6:11 was a new Worcester train added on April 30, 2001. The 3:45 train stopped at all intermediate stations to Boston. The other three made all stops to Wellesley Hills. The 5:40 and 6:11 trains then ran non-stop to Yawkey. The 6:30 ran non-stop to Back Bay, except that it also stopped at Yawkey for evening ballgames. The schedule in effect at the time of the 1993 survey was similar to the one in 2001, excluding the Worcester trains and the Yawkey stops, but some trains departed a few minutes earlier or later in 1993.

In April 2000, on-board passenger counts on all of the reverse-commuting trains then running on the Framingham / Worcester Line were conducted by CTPS. These show the number of passengers boarding and alighting at each stop, but do not show origin-destination pairs or trip purposes. Outbound, the later train was the more heavily patronized of the two. It left Boston with 96 passengers, picked up six more, and dropped off 65 before arriving in Framingham. At Framingham 37 passengers alighted.

Based on the total activity at each station, at least 31 of the Framingham passengers had to have boarded in Boston, but six probably boarded in Wellesley or Natick.

The earlier train left Boston with 79 passengers, picked up nine more, and dropped off 56 before arriving in Framingham. At Framingham 32 passengers alighted. Based on the total activity at each station, at least 23 of the Framingham passengers had to have boarded in Boston, but nine probably boarded in Wellesley or Natick. The combined results from the two trains indicate that a total of 54 passengers rode outbound A.M. peak trains from Boston to Framingham, and that another 16 rode to Framingham from Wellesley (9) or Natick (7).

Inbound, the 5:40 P.M. train was the most heavily patronized of the three, with 50 boardings at Framingham. At the stations in Natick and Wellesley another 90 passengers boarded and 12 alighted, so the train arrived in Boston with 128 passengers. Based on the total activity at each station, at least 38 of the Framingham passengers had to have ridden to Boston, but twelve probably rode only to Natick or Wellesley.

The 3:45 P.M. train from Framingham had 27 boardings there. By the time it reached Boston, this train had 88 passengers on board, of which at least 17 had to have boarded at Framingham. The 6:15 P.M. train from Framingham had only 20 boardings there. At the stations in Natick and Wellesley another 34 passengers boarded and four alighted, so the train arrived in Boston with 50 passengers. Based on the total activity at each station, at least 16 of the Framingham passengers had to have ridden to Boston, but four probably rode only to Natick.

The combined results from the three trains indicate that a total of at least 71 passengers rode inbound P.M. peak trains from Framingham to Boston. Another 21 apparently rode from Framingham to Natick (11) or Wellesley (10). The P.M. peak totals from Framingham to each other station exceeded the A.M. peak outbound totals to Framingham from these stations. This was typical of the patterns on most of the commuter rail lines, because along with reverse commuters P.M. peak inbound trains usually attract more non-work trips than A.M. peak outbound trains.

Framingham Station is located near the intersection of four Census tracts, each of which includes portions of the downtown Framingham business district. The 1990 Census indicated that in total 328 Boston residents were employed in these four tracts. This was more than the combined total in the tracts containing the Framingham Centre station site or that containing the Route 9 & 90 station site. Most of the employment locations in the four-tract group are within one mile of Framingham Station and many are within one half mile.

The 1993 survey found a total of only 12 Boston residents a day making trips home from work locations anywhere in Framingham via commuter rail, with 10 having origins in the four tracts around the station. Even allowing for a decline in Framingham employment between 1990 and 1993, commuter rail was capturing only about 3% of the reverse-commuting trips from Boston to the four tracts. By 2000, commuter rail was

still carrying the equivalent of less than 10% of the work trips from Boston to these tracts.

At the time of the 1993 survey, total ridership to Boston on just the two inbound P.M. peak Framingham trains was only half as large as in the Spring 2000 counts. These trains had 27 riders going from Framingham to the Boston stations, including eight (30%) returning to homes in Boston from work and two (7%) returning to homes in Boston from school. With the same proportions, the Spring 2000 ridership would have included 16 work-to-home trips and four school-to-home trips, from origins in Framingham to destinations in Boston, and 34 trips for other purposes. If the entire gain in ridership is assumed to have been in work-to-home trips, these would have grown to 35, assuming no losses in other categories. This would still have been equivalent to only about 10% of the reverse-commuting work trips from Boston to the four Census tracts surrounding Framingham Station.

Estimated Reverse-Commuting Work Trips on I-290 Extension

As discussed in preceding subsections, employers in the area that would be served by an I-290/Northborough commuter rail extension draw only small percentages of all of their workers from the city of Boston, and the percentage of all employed Boston residents working in the extension corridor is even smaller. Travel times from Boston to destinations served by an I-290 extension would be somewhat longer than present driving times. Therefore, if the extension were to induce significantly greater numbers of Boston residents than at present to find employment in its service area, it would have to be for reasons other than travel time.

At present, Boston residents without access to autos have limited options for traveling to points in the extension corridor, but there is some bus service available from downtown Boston. In Spring 2001, a bus leaving Copley Square at 7:45 A.M. was due at California Avenue in Framingham (near Route 9 & 90) at 8:20, which would have been suitable for the most common work-shift starting times in the Framingham Technology Park. In the evening, however, the inbound bus left California Avenue at 4:30, which would have been too early for most workers. An April 2000 count found only two riders for all destinations on the morning outbound trip, which then ran 17 minutes earlier.

The industrial area along I-495 in Marlborough was formerly served by a bus that left South Station at 7:10 A.M. and Copley Square at 7:25 and stopped at various points in Marlborough between 8:10 and 8:30. This was within the most common half-hour of starting time for workers in Marlborough. In the evening an inbound bus left stops in Marlborough at times ranging between 5:30 and 5:50. Workers who started between 8:00 and 8:30 may have found departures between 5:30 and 5:50 later than they would have liked. An April 2000 count found only one passenger using the outbound morning trip. This route was discontinued in April 2001.

In Spring 2001, Framingham LIFT Bus Route 7 connected with the most heavily patronized of the outbound A.M. peak commuter trains to Framingham Station, which was due there at 8:17, but the bus arrived at most work locations later than the times that most of their employees were supposed to be there. Recent figures on transfers between the train and the LIFT bus are not available. In the 1993 survey the LIFT system (which includes several routes in addition to Route 7) was used for P.M. peak train access by only two riders making work-to-home trips and two making school-to-home trips.

Based on the results of existing and recent past services, it can be concluded that implementation of reverse-commuting service from Boston to the I-290 extension corridor would have little impact on the total daily number of people making work trips from Boston to destinations in that corridor. Using the best available information on total reverse-commuting travel from Boston to the I-290 extension corridor and on the share of that market that rail service could be expected to capture, if service were in operation today with maximum feasible frequency, up to 190 outbound home-to-work trips would be served. Included in this number would be about 35 riders traveling only as far west as Framingham Station, but attracted by the increased flexibility in arrival and departure times compared with present service. Of the other 155 riders, about 100 would board at South Station or Back Bay, including some from points beyond Boston. The rest would board at stations in Wellesley or Natick or at Framingham Station. Because of the land use characteristics around stations and service characteristics compared with other alternatives, the number of passengers making reverse-commuting trips between pairs of stations on the extension would be too small to calculate.

If reverse-commuting service included only trains that would be run as a by-product of peak-direction service, there would be only one outbound A.M. peak trip and one inbound P.M. peak trip. This limited frequency and the specific arrival and departure times it would allow would reduce the number of reverse-commuting work trips to only about 25.

Estimated Reverse-Commuting School Trips on I-290 Extension

In addition to reverse-commuters going to work locations, off-peak-direction trains on several of the present MBTA commuter rail lines carry students going to and from schools. In general route lengths and station spacings are suitable mostly for travel to colleges, universities, and private academies rather than for short trips to public schools. One of the station locations on an I-290 extension assumed for purposes of analysis would be at Salem End Road in Framingham Centre, adjoining the Framingham State College Campus. Students who commute to colleges from off campus usually have a variety of needs for starting and ending times, depending on class schedules. Arrivals in time for classes starting at 8:00, 9:00 or 10:00 A.M. are usually the most popular.

With the schedule constraints imposed by other trains on the extension and main line, an outbound arrival at Framingham Centre at about 7:50 would be feasible. This would be convenient for students with 8:00 classes. It would be the same train as the one most heavily patronized for reverse-commuting to work, which as discussed above would be the most expensive to provide. The next two arrivals would be at around 8:25 and 9:00. The latter would be too late for students with 9:00 classes but some would find the former too early. With typical off-peak headways, the next arrival after 9:00 would not be until 11:00, so students with first classes at 10:00 would have to take the 9:00 train. Inbound service would include departures compatible with a variety of class ending times.

Based on counts at other stations adjoining college campuses, A.M. peak outbound student alightings at Framingham Centre would be expected to fall somewhere between the 26 observed at the station serving Bridgewater State College and the 94 observed at the station serving Brandeis University. Given the constraints on coordinating train arrivals with class starting times, a total below the average of the two, or around 50, would be expected. With only the minimum reverse-commuting frequency, this number would be reduced by at least half. More information on the travel needs of students commuting to Framingham State College would be needed to make more accurate forecasts of the use of an I-290 extension for such trips.

There would be no other colleges, universities, of private schools within walking distance of any of the assumed station locations on an I-290 extension. At present, some private secondary schools operate shuttle vans from commuter rail stations, and similar services could be established from some stations on an I-290 extension. The number of passengers using such services would be small relative to total ridership on the line, and students would pay only half fares. Therefore, whether or not such trips are included specifically in demand forecasts would make little difference in revenue estimates.

APPENDIX I - HISTORY OF I-290 EXTENSION CORRIDOR PUBLIC TRANSPORTATION SERVICE AND HIGHWAYS

Introduction

At present, public transportation service to Boston from most of the communities that would be served by an I-290/Northborough commuter rail extension is provided exclusively by buses, but these communities have had commuter rail service in the past. Most of the present bus routes have evolved from services established long ago, some of which were replacements for street railways. Despite increases in population and in Boston work travel from the corridor, the overall trend in public transportation service has been a great decline. The resemblance of the present bus routes to much older ones has resulted not from lack of attempts at change but from the failure of numerous newer routes to attract significant numbers of riders. From this history, it must be concluded that any future public transportation service to this area, whether by rail or bus, will have to be much more attractive than present or past transit alternatives to succeed.

Past Rail Passenger Service

Summary of Final Years

The Fitchburg Secondary Track, which would be the route of an I-290/Northborough commuter rail extension, has been used exclusively for freight service for a much longer time than is usually the case on lines evaluated by the MBTA for passenger service restoration. Historically the cities and towns that would be in the service area of the extension generated relatively small numbers of trips to Boston for all purposes. This has begun to change in recent years. Nevertheless, in 1990 only 1.2% of Boston Proper workers residing outside Boston lived in one of the extension service area communities other than Framingham. (Framingham alone accounted for another 1.2% of Boston Proper commuters.)

Rail passenger service on the segment of the extension route between Boston and Marlboro Junction and on the branch into downtown Marlborough ended in June 1937. Service continuing beyond Marlboro Junction to Fitchburg had been discontinued in April 1931. All of this service had been operated without public subsidies by the New Haven Railroad.

Marlborough continued to have direct rail passenger service over a different route operated by the Boston & Maine Railroad until April 1939. Trains on that route operated over a branch from downtown Marlborough to Hudson, continuing to Boston via the Central Mass. Branch. (The Central Mass. Branch and the line from Marlborough to Hudson are now both abandoned.) This service, like that on the Fitchburg Secondary, received no public subsidies.

Construction of the Fitchburg Secondary Track

Framingham to Northborough

The rail line that would be used for an I-290 extension was built in several stages. The oldest segment is that between Framingham Station and Framingham Centre, now included within the limits of the CSX Framingham North freight yard. This was built in 1849 as the Framingham Branch of the Boston & Worcester (B&W) Railroad. The main line of the B&W, now the MBTA Framingham / Worcester Line, had been completed from Boston as far as Westborough in 1834 and through to Worcester in 1835.

The B&W was originally part of a project to link Boston with the Hudson River at Albany, New York, primarily for long-distance freight traffic. With this objective foremost, several established town centers were by-passed by a few miles. After operating experience demonstrated the importance of local freight and passenger revenue, it was necessary to build branches to reach the areas that had originally been left out. One of these was Framingham Centre, on the route of the old Worcester Turnpike (now Route 9). The original B&W station, at about the same site as the present Framingham Station, was in a section of the town once known as South Framingham.

After construction of the Framingham Branch, shuttle trains carried passengers between Framingham Centre and main line trains at South Framingham. Several miles to the north of the B&W, the Fitchburg Railroad (now the MBTA Fitchburg Line) was completed through between Boston and Fitchburg in 1845. Between the routes of the B&W and the Fitchburg were a number of towns that were served directly by neither. This situation led to a round of construction of longer branch lines. Among these was the Agricultural Branch Railroad, which opened in June 1855 from Framingham Centre through Southborough to downtown Marlborough. It was originally planned that this line would continue through Marlborough to Northborough, but this was found to be infeasible because of several steep hills along the way. Therefore, the route to Northborough diverged from the Marlborough route at the border of Southborough and Marlborough at a point that became known as Marlboro Junction. The line as far as Northborough Center was completed in December 1855.

Service on the Agricultural Branch was initially run under contract by the B&W, by extending the trains that had formerly run on the Framingham Branch. It appears from schedules of that era, when travel time was less critical, that trains made side diversions into downtown Marlborough on the way to and from Northborough.

Northborough to Fitchburg

Prior to construction of the Agricultural Branch Railroad, two connecting lines between the B&W and Fitchburg Railroad had been completed further to the west. In 1848, the Worcester & Nashua (W&N) Railroad had opened between those two cities, crossing the Fitchburg Railroad at what is now Ayer. In 1850, the Fitchburg & Worcester

Railroad had opened between Fitchburg and a connection with the W&N at Sterling Junction in Sterling. Through passenger trains were run between Worcester and Fitchburg by arrangement between the W&N and the F&W.

In 1850 the Fitchburg Railroad had built a branch from the main line at South Acton through Maynard to Hudson. This line was extended to Marlborough in 1855, the same year that the Agricultural Branch reached Marlborough from the south. The two lines never connected. Their terminals were only half a mile apart, but had an 80-foot difference in elevation.

In 1866, the Agricultural Branch was extended northwest from Northborough to a junction with the Fitchburg & Worcester at Pratt's Junction in Sterling. Through passenger service between Framingham and Fitchburg was then instituted by arrangement between the two companies. In April 1867, the Agricultural Branch Railroad was re-named the Boston, Clinton, & Fitchburg (BC&F) Railroad. At about the same time, the company began running its own trains for the first time instead of contracting service to the B&W, and also assumed ownership of the former Framingham Branch.

The Boston & Worcester Railroad merged with the Western Railroad (Worcester to Albany) in December 1867, as the Boston & Albany Railroad. In July 1869 the Fitchburg & Worcester Railroad was merged into the BC&F with no further name change.

Further Expansion of the BC&F

The next expansion of the BC&F took place in 1870, with the leasing of the newly-opened Mansfield & Framingham Railroad between those two towns. In 1871 the BC&F leased the newly opened Framingham & Lowell Railroad, which ran from Lowell to a connection with the BC&F at Framingham Centre. This line also crossed the Fitchburg Railroad main line at West Concord.

In 1873, the BC&F leased the New Bedford Railroad system, and in 1876 they merged as the Boston, Clinton, Fitchburg & New Bedford Railroad. The New Bedford Railroad was itself the product of an earlier merger. It consisted of lines from Mansfield through Taunton to New Bedford and from Taunton to Attleboro.

The Old Colony Railroad, which operated most of the other rail lines in southeastern Massachusetts at the time, was opposed to incursion into its territory by the growing BCF&NB system. This led to the leasing of the latter system to the Old Colony in 1879 and a merger into the Old Colony in 1883. Ten years later the entire Old Colony system was leased to the New York, New Haven & Hartford Railroad (New Haven Railroad). This company would continue as the operator of the rail lines from Framingham to Marlborough and Fitchburg for over 70 years.

Competition from the North

A further addition was made to the rail network between the main lines of the Boston & Albany and Fitchburg Railroads with the opening in 1881 of the Massachusetts Central Railroad. This line ran from a connection with the Boston & Lowell Railroad system in North Cambridge through Belmont, Waltham, Weston, Wayland, and Sudbury to Hudson. Further extension was slowed by financial problems and a reorganization in 1883 as the Central Massachusetts Railroad. The Central Mass. reached its final terminal of Northampton in 1887. It crossed the former Boston, Clinton & Fitchburg Railroad on a trestle at West Berlin. A connecting track between the two lines was intended to be used for through passenger service between Boston and Fitchburg, but this was never instituted.

In 1887 the Boston & Lowell Railroad, which had been operating the Central Mass. under lease, was itself leased to the Boston & Maine Railroad, which assumed operation of the Central Mass. In 1900 the Fitchburg Railroad system was also leased to the B&M. This provided an opportunity to improve passenger service between Boston and Marlborough from North Station. The Central Mass. originally crossed the Fitchburg Railroad's branch from South Acton to Marlborough on a bridge east of Hudson. In 1903 the B&M built a connecting track between the two lines at that point, which became known as Gleason Junction, and implemented through service to Marlborough using a combination of the Central Mass. and the south end of the Marlborough Branch. This reduced the distance from North Station to Marlborough by over six miles, making it the same as that from South Station to Marlborough via Framingham.

Service Changes 1900 - 1937

In anticipation of increased traffic, the New Haven double-tracked the Fitchburg Secondary between Framingham Station and Southboro in 1905, and from there to Marlboro Junction the next year. In 1911, the New Haven Railroad and the New York Central System, to which the Boston & Albany was then under lease, entered into an agreement that gave the New Haven faster access to Boston from some of its branch lines by routing trains partly over B&A lines. Up to that time, trains from the New Haven's Fitchburg-Framingham route had been run into Boston using B&A crews east of Framingham. The new agreement improved efficiency by allowing New Haven crews to take trains all the way through.

Passenger service on the Fitchburg Secondary Track reached its historical maximum during the time that this agreement was in effect. In 1913, five round trips a day were run through between Fitchburg and South Station via Framingham, including one inbound train and two outbounds at times suitable for Boston work trips. An additional evening round trip ran between Fitchburg and Framingham Station, with good connecting service to and from Boston. Shuttle trains running between Marlboro Junction and the downtown Marlborough station made close connections with all six Fitchburg trains in each direction to allow travel between Marlborough and either Boston or Fitchburg or intermediate points. In addition, there was one through round

trip between Marlborough and Boston, with the inbound train running in the A.M. peak, and two through round trips from Marlborough to Framingham with good Boston connections. These included one outbound trip in the P.M. peak.
Despite the benefits to passengers, the New Haven and the New York Central were forced to terminate their cooperative agreement in 1914, as a consequence of federal anti-trust action. Some Fitchburg trains continued running through to Boston with B&A crews for a few years, but by 1919, most service on the line required Boston passengers to transfer at Framingham. The total number of trains on the lines was reduced gradually during the 1920s. In April 1931 all passenger service between Marlboro Junction and Fitchburg was discontinued. Service between downtown Marlborough and Framingham was maintained until June 1937, when it was also discontinued.

Service Changes After 1937

After the discontinuance of passenger service between Marlborough and Framingham, Marlborough continued to have rail passenger service to Boston via the combination of the Boston & Maine Railroad's Central Mass. and Marlborough branches until April 1939. Service between Hudson and Marlborough was discontinued at that time, leaving Hudson Station as the nearest location for Marlborough residents to board trains for Boston.

Southborough continued to be served by two stations on the Boston & Albany Main Line (now the MBTA Framingham / Worcester Line). These were Cordaville, where the new Southborough commuter rail station is to be built, and Southville, one half mile further west. For Northborough residents, the nearest rail passenger stations after the discontinuance of service on the Fitchburg-Framingham line were in Westborough on the B&A or Berlin on the Central Mass. These rail options for Marlborough, Southborough, and Northborough residents continued until the late 1950s. although service frequency gradually declined.

In May 1958 the outer terminal for Central Mass. passenger service was cut back from Clinton to Hudson, also eliminating service at Berlin. In April 1960 all intermediate stops on the B&A Main Line between Framingham and Worcester were discontinued. These included Cordaville, Southville, and Westborough as well as stations in Ashland, Grafton, and Millbury. Service on the Central Mass. which had been reduced to one round trip per day in 1959, was cut back from Hudson to South Sudbury in 1965. In November 1971, after a brief unsuccessful experimental increase to four round trips a day, Central Mass. service ended entirely. Since then, residents of Marlborough, Southborough, or Northborough, traveling to Boston by commuter rail have used stations on the Framingham / Worcester or Fitchburg lines.

MBTA figures for origins of passengers on all Boston commuter rail lines in 1966 showed 14 weekday boardings from Southborough, 11 from Marlborough, and 4 from Northborough. The corresponding figures from the 1993 commuter rail survey and

1995 Worcester Station survey were 26 from Southborough, 65 from Marlborough, and 9 from Northborough.

Changes in Track Ownership and Status

As noted above, the rail lines between Framingham Station and Fitchburg and between Marlborough Junction and Marlborough became part of the New York New Haven & Hartford (New Haven) Railroad system in 1893, when that company leased the Old Colony Railroad. The New Haven went into bankruptcy in October 1935. This resulted in cancellation of the Old Colony lease in June 1936, followed by bankruptcy of the Old Colony. The New Haven continued operating the Old Colony lines under court order, but began making cutbacks in both passenger and freight service to reduce expenses. The discontinuance of passenger service between Marlborough and Framingham in 1937 was among these. Also in 1937 the connecting link at Sterling Junction between the former Fitchburg & Worcester line and the former Worcester & Nashua Railroad (by then part of the Boston & Maine) was severed with the abandonment of track from Sterling Junction to Sterling Station. The second track from Framingham Centre to Marlboro Junction was dismantled about 1933.

Reorganization of the New Haven was completed in September 1947, with one of the elements being the merging of the remaining Old Colony lines into the reorganized company. The New Haven was profitable for a few years, but began operating with large deficits in the early 1950s. This resulted in the company going into bankruptcy again in 1961. Another round of track abandonments followed. The remaining spur from Pratt's Junction to Sterling was abandoned in 1962, followed in 1966 by the branch from Marlboro Junction to downtown Marlborough.

The bankruptcy trustees were unable to devise a plan for independent reorganization of the New Haven. On December 31, 1968, most of the assets of the New Haven were sold to the Penn Central Transportation Company, which had been formed earlier the same year through a merger of the New York Central Railroad with the Pennsylvania Railroad. Acquisition of the New Haven had been one of the conditions required by the Interstate Commerce Commission in approving the Penn Central merger.

The New Haven had never assigned names to any of its lines, instead always referring to them by their endpoints. Penn Central assigned names to all of the former New Haven lines shortly after acquiring them. The line from Framingham Centre to Fitchburg became the Fitchburg Secondary Track at that time. The segment from Framingham Centre to Framingham Station became part of the Framingham Branch, which also included the line from Framingham to Mansfield. The line from Framingham Centre to Lowell became the Lowell Secondary Track.

Penn Central itself was a failure, and declared bankruptcy in June 1970. Under the Regional Rail Reorganization Act of 1973, Congress created the Consolidated Rail Corporation (Conrail) for the purpose of operating a new rail system to be formed from lines of Penn Central and several other bankrupt railroads in the northeast and

midwest. Lines were selected for inclusion in Conrail primarily on the basis of anticipated freight traffic revenues relative to expenses. The Fitchburg Secondary Track and the Framingham Branch met the screening criteria, and were sold to Conrail when it commenced operation on April 1, 1976.

Conrail also acquired the segment of the Lowell Secondary Track between Framingham Centre and South Sudbury. Freight service between South Sudbury and Chelmsford was operated by Conrail under a contract from the Executive Office of Transportation and Construction from 1976 to 1982, when it was discontinued because of high cost and low traffic. EOTC initially leased and later purchased the right-of-way from South Sudbury to near Lowell from Penn Central, but there are no plans to restore rail service on it. The remaining segment between Framingham Centre and South Sudbury has been re-named the South Sudbury Industrial Track.

The segment of the Fitchburg Secondary Track between Fitchburg and Leominster was taken out of service by Conrail in the early 1980s because of lack of freight demand. It was not officially abandoned, and is still in place, however. The segment between Framingham Centre and Framingham Station has been re-designated as the Framingham North Yard. The Fitchburg Secondary Track, Framingham North Yard, and South Sudbury Industrial Track were all transferred to the CSX Corporation on June 1, 1999. At that time all assets of Conrail were divided between CSX and the Norfolk Southern Corporation which had jointly purchased Conrail.

Past and Present Bus Service in the I-290 Extension Corridor

Summary

Post Road Line

The bus route from Northborough to Boston via Route 20, known as the Post Road Line, has been operated by Cavalier Coach Corporation since September 1992, when the previous operator chose to leave the fixed-route business. Funding of this route under the MBTA Interdistrict Transportation Service (IDTS) program began in 1987. Prior to that, the route was unsubsidized.

This route is the last surviving remnant of a route between Worcester and Boston that was initiated in 1924. Until the early 1970s, service was run hourly throughout the day. Because of declining ridership, it was cut back to five round trips a day in 1973. Additional cutbacks occurred over the next decade. There have also been several changes in operators. Starting in 1984, only one round trip per day was run. The present operator is based in Boston. Since 1998 the early morning outbound and early evening inbound trips used to move buses between the garage and the outer terminal have been shown in schedules, but they carry few, if any, riders.

Marlborough Reverse-commuting Route

The reverse-commuting route from Boston to the Marlborough/Route 495 business area and the return trips between Marlborough hotels and Boston were started by Cavalier Coach in September 1998. Some funding for this service was provided through the IDTS program from July 1999 to April 2001. Because of very low ridership, the route was discontinued when IDTS funding ended.

Service to the Route 495 business area had not been tried previously. Service to Boston from the Marlborough hotels had been provided by Peter Pan Bus Lines in 1993, but was unsuccessful. That service initially included four inbound trips a day, including two in the A.M. peak, and six outbounds, including two in the P.M. peak. These were all run either as extensions of Edgewater/Shopper's World express trips, or as diversions of Worcester-Boston trips. Outbound trips stopped at Marlborough on request only. Service was cut back to three inbound and five outbound trips after a few months, and dropped entirely early in 1994.

Hudson-Boston Route

The route from Hudson to Boston via Framingham and the Mass. Turnpike was started by Gulbankian Bus Lines in 1988. It replaced a route from Southborough to Boston that had been started as a new service by the same company in 1981. Gulbankian is still the operator. The level of service has never exceeded the present four round trips per day, but there have been some adjustments in departure times. Prior to 1994, the only Boston stops on the route were at Copley Square and Park Square. This route has received funding through the IDTS program since September 1998.

Between Hudson and Southborough this route follows the same alignment as that formerly used by a Saturday-only route from Hudson to Shopper's World in Framingham. That route had been taken over by Gulbankian from another carrier in 1984. It also had weekday service until the early 1970s.

Hudson-Framingham Route

A route from Hudson to Framingham Station was operated by Gulbankian Bus Lines with funding from the IDTS program from September 1998 to August 1999. Between Hudson and Mass. Turnpike Interchange 12 in Framingham it followed generally the same route as the Hudson-Boston route discussed above. It then followed Route 9 and Main and Union streets to Framingham Station. Service on the portions within Framingham had previously been, and still is, operated by the Local Inter Framingham, Transportation (LIFT) system. The LIFT route was extended through Southborough to the Solomon Pond Mall in Marlborough in the Spring of 2000. The routing between Southborough and downtown Marlborough is slightly different from that of the route run by Gulbankian.

Worcester-Boston Route

The Worcester-Boston route that provides local service on Route 9 west of Shoppers World has had its present configuration since August 1999. At that time it replaced two older routes. One of these provided local service from Worcester to Boston, mostly on Route 9. The other made local stops from the Edgewater Hills condominium complex in Framingham to Shoppers World and then ran express to Boston on Route 9. The local route had been funded through the IDTS program since 1988. The express route was previously unsubsidized.

The Route 9 local service had been operated in various forms since 1931, when it replaced a trolley line. The Edgewater route had been started about 1972 as a short-turn of a Worcester route with the same configuration as that re-instituted in 1999. That route had been started in 1965 as a variation of the Worcester-Boston all-local route.

Earlier History of Bus Service in I-290 Extension Corridor

Street Railway Predecessors

The origins of all of the present bus routes to Boston from the I-290 extension corridor can be traced to trolley or early bus routes that were once operated by the Boston & Worcester Street Railway Company (B&W). That company opened an interurban electric railway between Boston and Worcester in 1903. It followed the present Route 9 between Brookline Village and White's Corner (White Bagley Road) in Southborough, but was largely on private right-of-way west of there. Tracks of the pre-existing local street railway system were used within Worcester. Between Chestnut Hill and downtown Boston the B&W used pre-existing trolley tracks of the Boston Elevated Railway.

Prior to completing their main route, the, the B&W interests bought up several small street railway companies operating in the Framingham area. The oldest of these was the Framingham Union Street Railway, which had opened as a horsecar system in 1888. It had two routes starting at South Framingham (Framingham Station). One of these ran to Framingham Centre Station via Union and Main streets and the Worcester Turnpike (Route 9). The other ran via Concord Street to Saxonville. These lines had been electrified in 1897-98.

The Marlborough Street Railway originally opened as an electric line in 1889, with a route from downtown Hudson through Marlborough to the northern border of Southborough. The Framingham, Marlborough, & Southborough St. Ry. opened in 1898. It was essentially an extension of the Marlborough St. Ry., which operated it from the start. It ran south from the border of Marlborough to the Worcester Turnpike at White's Corner, then east to the end of the Framingham Union St. Ry. at Framingham Centre.

In building the main line from Boston to Worcester, the B&W replaced the older lines on the Worcester Turnpike with new double track. The local companies were formally merged into the B&W in 1903 and 1904. After these mergers, the only significant expansion of the B&W's trolley system was the addition of a branch from the Worcester Turnpike to downtown Natick in 1909.

Early Bus Operations

In 1924, the B&W entered the motor bus business with a route between Worcester and Boston over an almost entirely different route from that of the trolley line. Between Northborough Center and Weston, this route mostly followed the alignment of the present U.S. Route 20 excluding more recent bypasses around town centers. Initially from Weston Center buses cut across to Route 30 via Newton Street and continued into Boston on Route 30. Within a few months the routing was shifted to Route 20 from Weston to Boston. Because Route 20 is also known as the Boston Post Road, the bus route has been identified as the Post Road Line during much of its history.

From Worcester to Marlborough this bus line followed a branch of the Worcester Consolidated St. Ry. The branch had opened in 1897 as the Worcester & Marlborough St. Ry., and had been merged into the Worcester Consolidated in 1901. It was converted to a bus line in 1929. Between Marlborough and the west side of Waltham the B&W's bus route provided new service. The rest of the way to Boston it mostly overlapped bus or trolley lines of the Middlesex & Boston St. Ry. or the Boston Elevated. The B&W's operating rights contained restrictions against serving local traffic on the segments that duplicated local routes of other companies. (In the 1950s, after the local bus route from Worcester to Marlborough via Northborough had been cut back to Shrewsbury, the B&W's operating rights were amended to allow passengers to be carried to Worcester from Marlborough or Northborough.)

During 1925 and 1926 the B&W obtained authority to operate buses on the Framingham local routes, on the Hudson-Southborough route, and on the Framingham-Boston segment of the main line. These rights were initially used to run bus service supplementing rather than replacing trolley service.

The B&W St. Ry. was reorganized in 1927 as the Boston, Worcester, & New York St. Ry. Trolley service on all of the local branches was phased out completely in favor of buses during the late 1920s. Trolley service on the main line between Worcester and Framingham Centre was replaces with buses running on the newly-constructed Route 9 in 1931. The remainder of the line was replaced with buses on Route 9 in 1932.

Bus Operations from 1930s to 1960s

During the 1930s, 40s and 50s the BW&NY started several local bus routes connecting new residential developments in the northern half of Framingham with Route 9 service and downtown Framingham. In the late 1940s, the company tried running "non-stop" deluxe bus service between Worcester and Boston on Route 9, but it apparently did not

last long. (This service was non-stop only in that there were no intermediate passenger stops, but buses would have had to stop for many traffic lights along the way.)

In the late 1950s the BW&NY experienced large ridership losses, attributed in part to the completion of the Mass. Turnpike west of Route 128 in 1957 and the opening of the Metropolitan Transit Authority's Riverside Extension (now the MBTA D Line) in 1959. The BW&NY was reorganized in March 1963 as the Boston-Worcester Corporation, which conducted business as B&W Lines.

Following the completion of the Mass. Turnpike extension from Route 128 to Boston in February 1965, B&W became one of the first bus companies to use it for new express service. In April of that year, B&W inaugurated semi-express service from Worcester to Boston. Buses used the old local route alignment via Route 9 from Worcester to Speen Street in Natick, then ran on the Turnpike from Interchange 13 to Copley Square, continuing on local streets to the Trailways terminal in Park Square. This was the first modern-day express bus service from Worcester to Boston. In August 1966 B&W also began running some peak-period Post Road line trips via Route 128 and the Turnpike between Weston and Boston. In July 1969, B&W inaugurated express service from Marlborough to Boston via I-495 and the Mass. Turnpike. By 1971, service on this route consisted of a single inbound A.M. peak trip.

In July 1971, the Boston-Worcester Corporation sold all of its operating rights to The Gray Line, Inc. This company had operated sightseeing buses in greater Boston since the 1920s but had not entered the fixed-route business until 1968. At the time of the sale, the B&W system included routes from Worcester to Boston via Route 9 and via Route 20 with variations partly on the Mass. Turnpike, and several local routes in Framingham, Natick and Wellesley.

Operation of the former B&W system by Gray Line was unsuccessful, and was soon followed by service cutbacks and sales of routes to other companies. The subsequent evolution of these operations into their present forms is most easily understood by tracing them individually.

Hudson-Marlborough-Southborough Service

The breakup of the B&W system had begun even before the sale to Gray Line. In September 1963, the Boston-Worcester Corp. discontinued service on the route between Hudson, Marlborough and Southborough that had replaced trolley service in the 1920s. This route had connected with the main Worcester-Boston route at Fayville (Central Street at Route 9). By 1963, ridership was about 130 each way per day. A local school bus and taxi operator, Hughes Bros. Bus Company, obtained temporary rights for replacement service on the same route. In December 1963 Hughes Bros. was granted permanent rights to the route and for a variation running from Southborough Center to Shopper's World in Framingham via Route 30.

In 1969 Hughes Bros. dropped most of the trips to Fayville, concentrating on Shopper's World service. Hughes Bros. operated this route until March 1973, but then went out of business after losing the Marlborough and Southborough school bus contracts. The new school bus contractor, Ritchie Bus Lines of Northborough, agreed to maintain service on the Hudson-Shopper's World Route, and obtained operating rights for the same routing formerly used by Hughes Bros. By early 1974, Ritchie had reduced service on the route to Saturdays only.

In April 1984, Ritchie sold the rights to the Hudson-Shopper's World Route to Michael Gulbankian, Inc. doing business as Gulbankian Bus Lines. This company maintained one Saturday-only round trip on the route.

Gulbankian had entered the fixed-route bus business in July 1981 by starting a new express route from Southborough to Park Square in Boston. This route began at the Gulbankian garage on Mt. Vickery Road, made a loop through the south side of town on Cordaville, Southville, Parkerville and Richards roads, then ran north on Route 85 to Route 30, and east on Route 30, Central Street, and Route 9 to Mass. Turnpike Interchange 12. The Turnpike was followed from there to Copley Square. Initially there was a single weekday round trip, inbound in the A.M. peak and outbound in the P.M. peak. The operating rights allowed passengers to be carried only between Southborough and Boston.

The startup of this route followed the restructuring of service between Boston and Worcester via Route 9 by the Gray Line and Suburban Lines discussed further below. Prior to the restructuring, bus service to Boston from points along Route 9 in Southborough had run express to Boston on the Mass. Turnpike from Interchange 12 or Interchange 13. The restructuring replaced most of this service with buses running all the way to Boston via Route 9.

In January 1988, the outer end of the Gulbankian route was extended from Southborough to Hudson via Marlborough by combining rights from the original route with some of the rights for the Hudson-Shopper's World route. Initially all of the original Gulbankian route between the bus garage and Route 85 at Route 30 (described above) was dropped. Service was expanded to three round trips per day, still with only one peak-period trip each way. Prior to this, the last through bus service from Marlborough to Boston other than that on the Post Road Line had been a route from a garage on Route 85 in the south edge of the city, run as an extension of the Shopper's World / Edgewater express routes. That service had been operated from 1980 to 1984, but apparently included no stops in Southborough.

About 1993, Gulbankian buses began making a side diversion to the Mt. Vickery Road garage, where park-and-ride facilities were offered. In 1994, the inner end of the route was extended from Park Square to South Station via the State House. About 1995 a stop was added at the Mass. Turnpike Framingham park-and-ride lot at Interchange 12.

Until 1998 Gulbankian ran the Shopper's World and Boston routes without subsidies. In September 1998, the company began receiving funding from the IDTS program. At that time, a fourth round trip was added to the Boston route. A new weekday service between Hudson and Framingham Station was added, with two round trips on weekdays. These were scheduled to connect to or from Framingham / Worcester Line commuter trains. The outer end of the route was the same as the Boston route. The segment within Framingham was new for Gulbankian, but overlapped routes of the Framingham LIFT bus service that dated back to the street railway era. This route lasted only until August 1999. Also as of September 1998 the Saturday-only route from Hudson to Shopper's World was replaced with a route from the Solomon Pond Mall in Marlborough to Framingham Station.

Post Road Line

Throughout most of its history prior to Gray Line operation, the Post Road bus line had hourly service at most times of day. Gray Line reduced off-peak service to every two hours. In September 1973 the operating rights for the route were sold to Ritchie Bus Lines, a Northborough charter and school bus operator. Earlier that year Ritchie had taken over the Hudson-Shoppers World local route.

By January of 1974 Ritchie eliminated through service from Worcester to Boston via the Post Road Line. Five round trips a day were run from Northborough to Boston, with two each way running via Waltham and three via the Mass. Turnpike east of Route 128. One separate round trip was run from Marlborough to Worcester on a schedule suitable for working in Worcester, but this was dropped by the end of 1975. The Waltham trips were dropped in 1976. Ritchie gave up the Post Road Line entirely in 1980, at which time Gray Line took it over again. Service was then down to two round trips a day, with one starting at Northborough and one at Marlborough.

At that time the garage for buses used on Gray Line's Shopper's World and Waterview express routes was on Route 85 in the south edge of Marlborough. When pulling in or out of service between the garage and route endpoints in Framingham, buses ran non-stop via Routes 85 and 9, but some trips picked up or dropped off passengers at the garage. In 1980 inbound departures allowing riders left the garage every 15 minutes for two hours in the A.M. peak with return trips every 15 minutes for two hours in the P.M. peak. By 1982 this service was cut back to one hour in the A.M. peak and two trips in the P.M. peak.

In late 1983 operation of the Post Road Line was transferred from Gray Line to Suburban Lines, which had been involved in various cooperative efforts with Gray Line for several years. Suburban maintained the single round trip each from Northborough and Marlborough. Service from the Marlborough garage lasted until 1984, when Gray Line gave up all Worcester and Framingham service.

Suburban Lines went out of business in 1984. A new company, King's Transport took over the Post Road Line. Both round trips were run from Northborough to Boston for a

few months, but in November 1984 service was reduced to a single Northborough-Boston round trip. This has remained the level of service under all operators since then.

In 1985, the Post Road Line changed hands once more, to Big W Trans of Ashland. This company had operated fixed-route service in the Framingham area since 1967. Big W began receiving funding for the Post Road Line through the IDTS program in 1987. In the Fall of 1992, Big W chose to get out of the fixed-route business. The operating contract for the Post Road Line was then transferred to Cavalier Coach of Boston. Limited information on past ridership on this route is available. In 1963, with 17 inbound trips, ridership was reported to average 419 inbound per day. At that time, there was also one train a day on the Central Mass. commuter rail line serving some of the same towns. In 1977, with bus service reduced to four inbound trips and the outer terminal cut back to Northborough, but no direct rail competition, a one-day count showed 102 inbound bus riders. In 1987, with one round trip per day, inbound ridership averaged only 15. By 1996 this had improved only slightly, to 17. Ridership in 2000 was still around this level.

Route 9 Worcester and Shopper's World / Waterview Service

As discussed above, for several years prior to the Gray Line sale, B&W Lines had been operating semi-express service from Worcester to Boston using the Mass. Turnpike east of Interchange 13 and Route 9 west of there. Around January 1972, Gray Line added non-stop Worcester-Boston express service. There were only two or three trips each way, all in commuting hours. Schedules indicate the routing as I-290, I-495 and the Mass. Turnpike. This service did not last long, as Worcester did not originate many Boston work trips then. At about the same time, Gray Line established a Shopper's World-Boston short-turn express service via the Mass. Pike in addition to service continuing through to Worcester via Route 9. Some of the Shopper's World trips originated at the Waterview (now Edgewater) apartment complex on Route 9 in western Framingham.

In February 1974, Gray line sold the operating rights for service between Framingham and Boston via Route 9 and for all of the remaining local routes in Framingham to Wellesley Fells Bus Lines, Inc., a former charter and school bus operator. Gray Line's plan was to concentrate on service to Boston from Framingham and points west. The semi-express route from Worcester to Boston via Route 9 and the Mass. Pike. and the Waterview / Shopper's World Express were retained. Through service from Worcester to Boston on Route 9 was discontinued. About the same time, Gray Line began running a few Worcester trips on the Mass. Pike from Interchange 12 in Framingham instead of Interchange 13, speeding up service to Worcester, Shrewsbury, Westborough and Southborough.

In December 1978, Gray Line also sold the Waterview / Shopper's World express service to Wellesley Fells, but retained the Worcester routes. Wellesley Fells went out of business abruptly in the summer of 1979. A new Gray Line subsidiary called Gray Line Framingham Commuter Corp. then took over the Waterview / Shopper's World route.

An independent company, Suburban Lines, took over the Framingham-Boston local service on Route 9 and the remaining local service in Framingham.

In 1980, Gray Line began running most trips between Worcester and Boston non-stop except for Shopper's World. These trips ran via Route 122 and the Mass. Pike instead of Route 9 west of Shopper's World. At the same time, Suburban Lines extended most trips on their Framingham-Boston local route through to Worcester on Route 9. This restored through operation on Route 9 for the first time since 1974, but also resulted in intermediate points between Waterview and Worcester being served mostly by local trips. The Gulbankian Bus Lines express route from Southborough to Boston was started in July 1981 to compensate for some of the loss in Gray Line service. By 1983, Gray Line service on Route 9 was down to one inbound trip from Worcester and one outbound trip to Westborough .

In 1984, Suburban Lines went out of business and was succeeded as operator of Worcester-Boston local service by Marathon Lines, formerly an affiliated charter bus company. The same year, Peter Pan Bus Lines began operating Worcester-Boston express bus service in competition with Gray Line. Peter Pan had been operating bus service between Springfield and Boston since 1933. This service initially ran via old state highways. Over the years, the company acquired operating rights to several route variations, including use of the Mass. Pike as soon as it opened. Some of Peter Pan's Springfield buses made intermediate stops in Worcester, but the Department of Public Utilities had a long-standing policy of protecting the oldest carrier in any market. The original bus service of the Boston, Worcester & New York St. Ry. to which Gray Line had become successor, slightly pre-dated Peter Pan's service through Worcester. Therefore, Peter Pan's operating rights stipulated that no passengers could be carried whose entire trips were between Worcester and Boston.

The rules changed with the passage by Congress of the Bus Regulatory Reform Act of 1982. This act gave the Interstate Commerce Commission broad new powers to overrule state regulatory agencies in order to further national transportation goals of efficiency and energy conservation. This power was used in the next few years to strike out service restrictions in many bus operating certificates. Peter Pan successfully appealed the restriction against carrying Worcester-Boston passengers, and inaugurated service in June 1984.

Gray Line soon lost so much of the business that it withdrew from the Worcester-Framingham-Boston corridor in the Fall of that year. This resulted in the end of the remaining semi-express service to Boston from points on Route 9 west of Waterview. Gray Line sold the Waterview / Shopper's World express service to Priority Express, a new company affiliated with Marathon.

In April 1987, Marathon began receiving funding for Worcester service on Route 9 through the IDTS program. Some semi-express service from Westborough via Route 9 and the Mass. Turnpike was reinstituted as well. In April 1988, Marathon shut down, with operation of local Route 9 Worcester-Boston service being taken over by a new

company doing business as Ace Line. In August 1988 both this route and the Priority Express Waterview / Shoppers World route were takeover by Peter Pan Bus Lines. (The name of the Waterview complex was changed to Edgewater in 1989.)

Shortly after taking over the Route 9 service, Peter Pan announced plans to abandon it. It was saved by a subsidy from the MBTA Interdistrict Transportation Service Program, but was cut back to 8 inbound and 9 outbound trips per day. Further reductions followed, and in 1997 service was cut back to only three round trips per day, all in off-peak hours.

Since the resumption of commuter rail service to Worcester in the Fall of 1994, Peter Pan has made substantial cutbacks in the Worcester and Edgewater / Shoppers World express routes, and has combined most of the service on the latter with trips on other routes. In August 1999, through service from Worcester to Boston on Route 9 was discontinued. It was replaced by two round trips a day running local from Worcester to Shopper's World on Route 9 and then continuing to Boston via the Mass. Turnpike. These also replaced two former Edgewater-Boston round trips.

Background of Highways in I-290 Extension Service Area

Recap of Major Highways

The primary service area of an I-290 / Northborough extension is linked with Boston by four east-west numbered highway routes. These are state routes 9 and 30, U.S. Route 20, and the Massachusetts Turnpike (Interstate 90). Of these, only the Mass. Turnpike is a limited-access highway. Route 9 is a multi-lane divided highway, but with unlimited access. Routes 20 and 30 are undivided mostly two-lane highways. From some towns in the extension service area, the fastest, though not the most direct, highway route involves a combination of Routes I-290 and I-495 and the Mass. Turnpike.

Routes 9 and 30 run directly through Framingham and Southborough and also through Westborough. The Mass. Turnpike also runs through all three but has interchanges only in Westborough and Framingham. Route 9 and the Mass. Turnpike can be accessed from Northborough and Marlborough via either Interstate Route 495, state Route 85, or parallel unnumbered roads. Route 30 connects directly with Route 85 but not with I-495. Route 20 runs directly through Northborough and Marlborough and also through Sudbury and Shrewsbury. (Shrewsbury is also on Route 9.) Route I-290 runs through Shrewsbury and Northborough to I-495 in Marlborough.

As would be expected, the Mass. Turnpike is currently the most heavily used of the four highways connecting the I-290 extension corridor with Boston. A 1998 count found 110,731 vehicles a day east of Interchange 13 in Framingham. On Route 9 at its eastern junction with Route 30 in Framingham (roughly parallel with Turnpike Interchange 13) a 1998 count found 52,200 vehicles a day, or slightly less than half the number on the Turnpike. A 1999 count on Route 20 east of Route 27 Wayland Center found 23,100 vehicles a day, or about 20% of the level of traffic on the Mass. Turnpike at the same

distance from Boston. Recent comparable counts for Route 30 are not available, but in the past it has carried somewhat lower traffic than Route 20. A 1999 count found 68,800 vehicles a day on I-290 just west of I-495, but much of this traffic would have been destined for points other than Boston.

General Highway History

The older state highways in the area evolved gradually along the locations of early wagon roads. In the early 1900s, motorists had to depend on privately published maps and route description books to find the best routes for intertown travel. Commuting to and from work if one did not live and work in the same city or town was done mostly by railroad or street railway. As roads improved and longer-distance driving became more feasible, a simpler method of designating through routes became necessary.

Around 1920, bands of various colors were attached to utility poles along main highways throughout New England, to mark routes in the manner of hiking trail blazes. A new federal program begun in 1921 provided funding for states to improve highways that could be used for intercity travel. These were to be designated as U.S. highways, and were to be numbered and identified with standardized posted signs. Massachusetts began applying these numbers in 1926, and also began numbering other state highways at the same time. Some of the original numbers were changed in the first few years for consistency with the U.S. Highway numbering system.

Construction of the Interstate Highway system was initiated by the federal Interstate Highway System Act of 1956. Much of the system consisted of entirely new roads, but Interstate highway numbers were also applied to some routes already open or under construction by 1956 if they conformed with Interstate standards and formed needed links in the Interstate system.

Specific background information on the main highways in the I-290 extension service area is contained below.

Further Background on Individual Highway Routes

U.S. Route 20

Of the four main highway routes linking the I-290 extension service area with Boston, Route 20 is the oldest. From Northborough east, most of the alignment was part of the northern Post Road between Boston and New York, designated in 1673, but even then following pre-existing roads. For many years it was the main highway between Boston, Worcester, and points west. Around 1920 it was made a "banded-pole" route with red markers. The section east of Worcester was identified as the Hubway, indicating its significance as a route to Boston.

When highway numbering began, the number initially given to this road was Route 5, but by 1930 it had been changed to U.S. Route 20. Improvements to Route 20 by the

Massachusetts Department of Public Works (MDPW) in the early 1930s included construction of bypasses around Weston Center and around the Wayside Inn in Sudbury and Marlborough. West of downtown Northborough, Route 20 initially followed West Main, North, Prospect, and Maple streets to Route 9 in Shrewsbury. The present alignment west of Northborough Center to Route I-84 in Sturbridge, known as the Southwest Cutoff, was built as an almost all-new road, also in the 1930s.

Route 9

The alignment of Route 9 between the eastern edge of Worcester and the western edge of Boston was mostly built new as the Worcester Turnpike, a privately-owned toll road, which opened in 1808. This enterprise was unprofitable. Segments of the road were gradually turned over to the counties through which it ran and became free between 1833 and 1841. After that, the segment between Southborough and Shrewsbury was used mainly for local travel for many years. In the late 1920s the segment between Framingham Centre and Brookline Village was given the designation state Route 115.

The entire route from Worcester to Boston was substantially rebuilt by the MDPW in 1930-32, and became state Route 9. This work included construction of overpasses or underpasses at several major intersections, and replacement of a trolley reservation between Southborough and Brookline with additional road lanes and a median barrier.

Route 30

Much of the present Route 30 follows alignments of local roads that were in existence by the 1830s. The longest newer segments are on portions of Commonwealth Avenue through Newton, Brighton, and Allston which were constructed as new boulevards in the 1890s. The Route 30 designation was first applied in the early 1930s. Prior to that, the segment from the eastern edge of Weston to Boston was part of Route 20A, which connected with Route 20 in Weston Center via Newton Street.

Massachusetts Turnpike / Interstate 90

The Massachusetts Turnpike first opened from the New York state line at West Stockbridge to state Route 128 in Weston in 1957. Because of difficulty in acquiring a right-of-way east of there, traffic from the Turnpike was initially routed into Boston via Route 128 and Route 9. The Turnpike extension opened from Route 128 to the Allston toll booths in 1964, and to the Central Artery in 1965. Construction of the Turnpike pre-dated the creation of the Interstate Highway system, but the Interstate 90 designation was applied by 1960.

Interstate Routes 495 and 290 and State Route 85

Route I-495, also known as the Outer Circumferential highway, was mostly built new as part of the Interstate Highway system. The segment linking Northborough and Marlborough with Route 9 opened in 1963, and was extended to the Mass. Turnpike

about 1968. Much of the north-south traffic in this area had previously followed state Route 85.

The Route 85 designation was first applied along all or most of the present alignment in Southborough, Northborough and Hudson in the late 1920s. It followed roads that had been in existence by the 1870s.

Route I-290 was completed from the Mass. Turnpike at Interchange 10 in Auburn through Worcester to I-495 in Marlborough about 1970. A connector from I-495 to Route 85 in Marlborough is effectively but not officially an extension of I-290. It was completed about 1982.